THE COLLECTING NET

Vol. VI. No. 1 SATURDAY, JUNE 27, 1931 ANNUAL SUBSCRIPTION, $2.00
SINGLE COPIES 25 CTS.

THE BIOLOGICAL LABORATORY AT COLD SPRING HARBOR

DR. REGINALD G. HARRIS

Director of the Laboratory

The Biological Laboratory at Cold Spring Harbor of 1931, is in many ways, a different institution from that of 1928 when I last had the opportunity of writing about it for THE COLLECTING NET. This is due, not to a change in aims, but to a realization of some of them, and to a partial fulfilment of certain of the prophecies which were made at that time.

One of the most significant of these changes is the formation of a small permanent staff of investigators who carry on their work at the Laboratory throughout the year.

The development of biology in the last generation has necessitated marked changes in biological laboratories, and seaside laboratories have been found to move along in the procession. There was a time when nearly all the summer laboratory had to supply was a building in which to work and a place to sleep. The Marine Biological Laboratory at Woods Hole and the (*Continued on Page* 3)

THE HEME PIGMENTS AS OXYGEN CARRIERS AND AS OXIDATION CATALYSTS

DR. LEONOR MICHAELIS

Member, Rockefeller Institute

Hemoglobin consists of globin, a protein, and heme, a compound of iron with a porphyrin molecule, which in its turn is a complicated ring made up by the linkage of four pyrrhol rings. Hemoglobin can be oxidized in two different ways. Either it combines reversibly with molecular oxygen without the iron atom being oxidized from the ferro state to the ferri. This is called oxygenation. Or the ferro state is oxidized to the ferri, a true oxidation, and the oxidized hemoglobin is called methemoglobin. Many iron-porphyrin compounds are found in all cells and tissues. They belong to the family of the hemin compounds, namely the various forms of cytochrome as found by Keilin and Warburg's respiration ferment.

The oxidation of hemoglobin to methemoglobin can be performed by various oxidants, but does not take place with any appreciable rate when molecular oxygen is used as oxidant, oxygenation

M. B. L. Calendar

TUESDAY, JUNE 30, 8:00 P. M.

Evening Seminar. Dr. G. S. Dodds, "Oseoclasts and Chondroclasts".

Dr. A. W. Pollister, "The Architecture of the Liver Cells of Amphiuma".

Dr. G. H. Parker, "Passage of Sperms and Eggs through the Mammalian Oviduct".

FRIDAY, JULY 3, 8:00 P. M.

Evening Lecture. Professor E. B. Wilson, Da Costa professor emeritus, Columbia University, "The Central Bodies".

TABLE OF CONTENTS

taking place instead. Hemoglobin is, therefore, not autoxidizable. This, of course, is the condition necessary for its ability of acting as oxygen carrier. Most of the other heme compounds, in their ferro state, in contrast herewith, are autoxidizable and can be oxidized directly by molecular oxygen to the ferri state. This is the condition necessary for an iron compound to act as an oxidation catalyst, i. e., a catalyst which enables the otherwise inert oxygen to act as oxidant for organic foodstuffs.

The problem of this lecture is to correlate the chemical constitution of an iron compound with its property either as oxygen carrier or as oxygen catalyst. We have to consider as an introduction to this problem the general properties of ordinary complex iron compounds.

A complex compound arises when the electron pair which represents the chemical bond is furnished by only one of the two atoms which are to combine. The accepting atom (Fe) utilizes the electron pair furnished by the donator (say, the cyanide-ion) to fill up its electron shells to that complete state which is found in the noble gas krypton. Taking into account the number of electrons already present in the ferro ion, just six cyanide ions turn out to be necessary to fill up the electron shells to the krypton model. A main valence, in contrast herewith, is a shared electron pair of which one electron is furnished by one, and the other electron by the other of the two atoms which are to combine.

In the heme compounds, the four nitrogen atoms of the four pyrrhol groups are attached to the iron. Two of them are present as NH, and the H atom must be replaced by the Fe atom. They may be said to be attached to Fe by main valences. The other two are present as N without H. They may be said to be attached to the iron by coordinative or residual valences. For spacial reasons only one molecule of the porphyrin can combine with iron, although it occupies only four of the six available coordination places of the iron atom. Thus, two places are free which can combine on the one side with such molecules as globin or pyridine or nicotine, etc., and on the other hand with such molecules as O_2, or CO, or the cyanide ion, etc.

In order that a ferro compound be oxidized to a ferri compound, the iron atom has to eject one electron from its kernel and to deliver it to the oxidant which thus is reduced. It is easier for the iron atom to throw off this electron when the iron atom is in an electro-neutral state than when it is positively charged, on account of the electrostatic attraction. Therefore all iron compounds in which the iron atom is present in the neutral state should be expected to be autoxidizable and all iron compounds in which the iron atom carries its ionic positive charges should be difficult or not at all autoxidizable. This has been experimentally proved by C. V. Smythe in my laboratory. The majority of the iron complexes are easily autoxidizable, e. g., the complex with tartaric, oxalic, phyrophosphoric acid. Here the positive charges of the ferro ion are abolished by neutralization due to the negative charges of the acidic ions which combine with the iron through main valences. On the other hand, the ferrous ion itself as it is present in an acid solutoin of ferrous sulphate, or in the iron complex compound of alpha-alpha'-dipyridyl, or of phenanthrolin, is not autoxidizable. In these cases the ferrous ion remains positively charged even in the complex compound because it is held only by residual valences. The N-atoms of the two just mentioned compounds contain no H-atoms attached which could be replaced by the iron and thus could establish a main valence. All six valences of the complex consisting of one ferro ion and three molecules of dipyridyl are residual valences, and the ferrous ion remains doubly positively charged. Therefore it is not autoxidizable.

As hemoglobin is not autoxidizable the hypothesis is offered that those two nitrogen atoms which in ordinary porphyrin compounds are present in the form of NH, are present in the porphyrin which is part of hemoglobin without a hydrogen atom attached. As porphyrin contains several unsaturated linkages and unsaturated side chains, it is not difficult to imagine that the two hydrogen atoms are shifted to such unsaturated places. This shift is supposed to be intrinsically connected with the attachment of globin. Details cannot be offered, however, as yet. Such an hypothesis would explain why hemoglobin is not autoxidizable, and it may serve as a working hypothesis and leading idea for the chemical research of hemoglobin, the constitution of which is not known in any detail at all.

Most of those other heme compounds which are derivatives of the ordinary porphyrin compounds are expected and are proved to be autoxidizable.

The problem as to under what condition a compound can act as reversible oxygen carrier can be answered in this way. It is more than likely that any ferro-complex which is autoxidizable can form an oxygenated ferro compound as a very transient intermediary state between the ferro and the ferri state. One of

the various evidences for this assertion is the fact that such ferro compounds can form molecular compounds with carbon monoxide or with the cyanide ion, which are always competitive with molecular oxygen in complex formation. So our problem is reduced to the question: When is such an oxygenated ferro compound stable instead of being a transient state between ferro and ferri?

The answer is this. First of all, the ferro compound must not be autoxidizable. Otherwise, the oxygenated compound would not be stable. In the second place, at least one of the six coordination places must be available for the oxygen molecule to combine with. The first condition is fulfilled for a compound such as the tri-dipyridyl complex of ferrous iron. But the second condition is not fulfilled because all six coordination places are exceedingly tightly occupied by the six N-atoms of the three dipyridyl molecules. But in hemoglobin, two coordination places are free and available for other molecules. One of them may be thought of as occupied by globin, and the second is available for oxygen or carbon monoxide or cyanide, which are competitive with each other in their combining power to hemoglobin.

So it has been shown that the constitution of the porphyrin is in an ideal way adapted to the physiological purpose to work in combination with iron, either as oxygen catalyst, or by a slight modification of the structure, as an oxygen carrier.

THE BIOLOGICAL LABORATORY AT COLD SPRING HARBOR

(Continued from Page 1)

Biological Laboratory at Cold Spring Harbor were direct descendants of Agassiz's mental child "Study Nature not Books," and in the early days of both institutions field trips and general biological and ecological observations were the chief activities of the biologists and students for whom the laboratories were formed. A microscope and a little glassware were nearly all that were needed even by the most exacting. For some time the biologist could easily bring with him all of the apparatus he would need during the summer, and this could be set up without loss of time.

While it is unquestionably still possible to make important discoveries when one is armed only with a microscope, a few chemicals, a modest supply of glassware, and some unsuspecting marine animals, or eggs, the group of biologists which limits itself to such needs is relatively small. The researches of many others seem to demand intricate and delicate apparatus, and equipment that appears to be far from modest.

To deny such biologists the privilege of working at a seaside laboratory would be unfortunate both for the biologist and for the laboratory, and biology would suffer by reducing the scope of its most active, and probably its most valuable, clearing houses.

The result is that seaside laboratories, dedicated primarily to research and to the advancement of biology in the most fundamental sense, have found it necessary to equip themselves with apparatus and other facilities of considerable value. In order to house properly such apparatus suitable buildings must be provided, and almost before we know it the plant of a modern summer laboratory for biological research comes to represent an investment of several hundreds of thousands of dollars rather than a few thousand dollars, as it did formerly.

Unquestionably such an investment is eminently worth while. The results, both visible and invisible, of the functioning of summer laboratories in this country for the last forty years have been so great as to warrant much larger expenditures. But it is equally true that to have such valuable establishments for research used actively for only a very few months each year, is unfortunate.

The more the plant can be put to productive use throughout the year the greater becomes the return upon the investment, and in general, paradoxically enough, the longer the life of the equipment. Anything desirable which may be adopted to bring this about is an obvious good.

All these are factors which entered very strongly into the mental attitude which has led to the formation of a small permanent staff at the Laboratory at Cold Spring Harbor.

At the same time we believe that the active promotion of research throughout the year gives an atmosphere to the whole laboratory which the summer investigator and the student find agreeable and stimulating.

The permanent work has been arranged with a view to its value to the summer work as well as to its intrinsic value.

The biophysical laboratory should serve admirably to illustrate this point. The research in biophysics is of a very broad and fundamental nature. It is concerned with, (1) the chemical action of X-rays, with a view to carrying these studies to the point where cells and tissues may profitably be employed as experimental material; (2) soft X-ray photography is being intensively studied with the hope of developing its applications to biological research; (3) the electrical

capacity of biological cells and systems, and their resistance to electric currents of high frequency are subjects of major research at the laboratory for biophysics because of the value which, in all probability, will accrue to biology from additional discoveries concerning them.

The equipment entailed by these studies, a high voltage transformer, X-ray dosimeter, soft X-ray outfits, vacuum pumps, high temperature electric ovens, glassblower's shop, machine shop, special apparatus for gas analysis and for titration, modified wheatstone bridge, all this is being supplemented by other physical equipment which may be used to advantage in biological problems.

Indeed for certain experimental work in biology Agassiz's motto might well be extended now to include apparatus. Thus the location of a biophysical unit at a summer laboratory becomes a matter of considerable importance as a source of new tools for biological research. It provides an unusual opportunity for the many biologists, both students and investigators, who are interested in the possibilities of applying physical methods to biological problems, to become acquainted with such methods, and with machines, their construction, and uses.

In this connection it is significant that we have appointed a physicist in charge of the biophysical laboratory here. Biophysics is clearly an applied science. It involves the application of physics to biological research. It would seem axiomatic then that a physicist should be in charge of the laboratory which is to construct machines and work out methods by which physics may be further applied to biological research. The value of such a man, and of such a laboratory, to the summer work of the Biological Laboratory, is obvious.

The all year staff is envisioned as having unusual flexibility, in respect to the number of its members, and the nature of its works. The Biological Laboratory dces not wish to be permanently committed to any division of biological research. Its summer visitors represent nearly every branch of biology, and it is desired that any further development of the all year staff be broad in its basis and fundamental in its conception. No appointments are permanent. The continuance of any work depends upon its apparent value to biology and upon the ability of the Laboratory to sponsor it. At the present time five different types of work are being supported by the Laboratory throughout the year. In addition to biophysics, researches are being conducted in pharmacology, in physiology of reproduction, and in certain aspects of bacteriology, and the publication of a series of monographs on the Bryophytes, is being accomplished. During the last two years the Laboratory has helped support, throughout the year, the researches of Drs. W. W. Swingle and J. J. Pfiffner on the adrenal cortex, but aid from other sources makes this no longer necessary.

The research in pharmacology is concerned with the action of drugs and factors modifying such action, notably the relative amount of calcium in the blood stream, the relative acidity of the blood and, in the case of isolated organs, of surrounding fluids, and the effect of diet.

The research concerning the physiology of reproduction is based upon factors regulating pregnancy, more especially the corpora lutea.

Two of the laboratory buildings are in use throughout the year, and several houses are kept open for staff members, their associates and assistants.

A second significant change in the Laboratory during the last three years may be seen in a further increase in the number of those carrying on research there. During the summer of 1928 there were, at the Laboratory, twenty-four people engaged in sereach. This summer there are about fifty. The number of students remains relatively constant at about thirty-five. All of the courses now give marked attention to individual research. Indeed the course in Field Zoology, which at one time was known as the course in High School Biology, has advanced to the point where each student engages in an individual problem of research as half of his work in course.

The courses given include, in addition to Field Zoology, Field Botany and Plant Ecology, General Physiology, and Surgical Methods in Experimental Biology, while a series of lectures are offered in Endocrinology.

A staggering of courses, somewhat similar to that which was inaugurated at Woods Hole two years ago, is now entering its second summer at Cold Spring Harbor. This system has been applied to the courses in Field Zoology and in Field Botany, Zoology being given from about the middle of June to the end of July, while botany is offered during August and the first part of September. This has appeared to bring forth several benefits, of which the use of student laboratories and living quarters for twelve weeks, rather than six, with its consequent saving of space is one of the most important. At the present time only about one-fifth of the total laboratory space is given over to students during the summer. The research carried on during the summer covers, as would be expected, a wide variety of subjects. Investigators at seaside laboratories have

long since ceased limiting themselves to marine material. Yet Cold Spring Harbor is probably unique in the high percentage of investigators who make use of mammals for experimental purposes. At the same time, good advantage is taken of the abundant marine material at hand. Three of the five laboratory buildings are equipped with running sea-water, and a number of students and workers make use of the facilities thus available.

The management of the Laboratory continues to rest ultimately with the Board of Directors, which is composed of about equal numbers of biologists and laymen. Among the members of of the Corporation there is likewise a relatively high percentage of laymen. Even the Executive Committee contains members of each group, and it is particularly interesting to note that the President of the Long Island Biological Association, which maintains and controls the Laboratory, is not a biologist.

In many ways this representation of laymen among the officers and on the governing board has been highly beneficial. Much needless discussion and delay are obviated in board meetings, since legal and financial, as well as biological, questions can receive immediate expert evaluation. The varied experience in legal and financial enterprises, in the workings of large industral research laboratories, in the management of hospitals, universities, colleges and medical schools, which these laymen bring to deliberations of the Board are very valuable.

At the same time the points of view of those who regularly work at the Laboratory are ably represented by the biologists who are members of the Board, while every biologist of attainment intimately associated with the Laboratory is a member of the Scientific Advisory Committee, whose recommendations play a very important part in the development of policy and the conduct of affairs.

Sub-committees of the Scientific Advisory Committee take up special problems, while an Executive Committee of seven members takes action on pressing matters in intervals between meetings of the Board of Directors. The Director of the Laboratory is in residence throughout the year. There is an active Women's Auxiliary and a membership of about two hundred and fifty in the corporation.

Quite beyond the benefits in management which the Laboratory enjoys as a result of having lay members in its Corporation and on its Board, there can be no question but that the interest in biological research which is aroused by such an organization as the Long Island Biological Association can be made of enormous value to biology in this country. It is probably safe to say that since the transfer of the Biological Laboratory from the Brooklyn Institute of Arts and Sciences to the Long Island Biological Association in 1924, over a quarter of a million dollars, which would probably never have found its way into funds for the advancement of biology, has been contributed to the Biological Laboratory alone. It is also true that the Department of Genetics of the Carnegie Institution of Washington, located at Cold Spring Harbor, has also benefitted financially from the interest in biological research evoked among wealthy laymen of this region by the Long Island Biological Association. It would not be surprising if many other biological institutions should also benefit directly, in the course of time. Indeed biologists and biological laboratories, for the sake of the maintenance and growth of biological research of the future should not only increase the basis of fact and observation upon which it may stand, but should insure its financial well-being by interesting in its value and possibilities those in a position to give to its support. The more rapidly this can be accomplished, the more rapid will be the increase in biological knowledge. Its accomplishment will place almost unlimited potential funds within the reach of the science which biologists are attempting to serve, and the understanding of life and the philosophy of living which their work advances. It will likewise give pleasure to the laymen who become interested.

It is significant to note, by way of parenthesis in this connection, that the recently reorganized station at Bermuda has adopted this policy in respect to the formation of its Board of Directors, and, indeed, has carried it a step further in electing laymen of more than one nationality.

The measurable advantages which have come to the Laboratory at Cold Spring Harbor since it has been under the management of the Long Island Biological Association are many. Three laboratory buildings have been erected, including the George Lane Nichols Memorial, and the Doctor Walter B. James Memorial Laboratory. A fourth laboratory building has been made available by remodeling the old lecture hall. Three dwelling houses have been procured and remodeled to provide small suites for investigators and their families. Over thirty acres of land have been purchased to provide sites for buildings, and opportunities for biologists to erect homes near the Laboratory. The grounds and buildings have been greatly improved in appearance and usefulness. Finally, the scientific and administrative equipment of the Laboratory has been

increased many hundred fold. All of this represents a marked increase in the assets of the Laboratory which are now evaluated at over $400,000. At the same time the annual budget for operating has increased from about $7,000 to about $78,000, and the Laboratory seems to be holding its own during the present period of serious financial depression.

Unfortunately the Laboratory is not yet provided with anything like an adequate endowment fund. Likewise the library is unimposing. But a beginning has been made in the formation of a library and headway is being maintained. The library of the adjoining Department of Genetics, Carnegie Institution of Washington of 12,000 or more volumes, largely serials, is available for the use of investigators at the Laboratory.

Evening lectures are given during the summer, and estates and gardens nearby are visited on Saturday and Sunday afternoons. The social life of the Laboratory is quiet and informal.

Contrary to usual custom, I have held a short historical sketch of the Laboratory until the end, in the belief that those already acquainted with the history should have an opportunity of becoming informed of recent developments at Cold Spring Harbor without the necessity of being subjected to a recitation of their historical background. For those not familiar with that background the following may be of interest. I wish, however, to accept this opportunity of expressing to the officers, members and students of the Marine Biological Laboratory, through The Collecting Net, my best wishes for an agreeable and profitable summer.

In its founding at Cold Spring Harbor in 1890, as a branch of the Brooklyn Institute of Arts and Sciences, the Biological Laboratory was endowed with ideals and policies which were to control, almost completely, its development for nearly thirty-five years, and, to some extent at least, to the present time. One of the founders, Professor Franklin W. Hooper, Director of the Brooklyn Institute, had, through his personal acquaintance with Prof. Agassiz's station at Penikese, acquired the marine biological enthusiasm which two years previously had led to the establishment of the Marine Biological Laboratory at Woods Hole. Another founder, Mr. Eugene G. Blackford, fish commissioner of New York, who brought in his interest in fisheries and the utilitarian point of view so pronounced in certain European marine laboratories; while a third founder, Mr. John D. Jones gave to the newly established laboratory the aid and attitude of a wealthy layman interested in biological instruction and research.

The Laboratory was early provided by Mr. Jones and his brother with about three acres of land and four buildings, including a newly erected laboratory. This property was, together with certain moneys, placed in the hands of the Wawepex Society. This Society continues generously to place this property at the disposal of the Laboratory, and to contribute to its support Dr. Bashford Dean, the first director of the Laboratory, was of considerable help in interesting Mr. Jones in this action, which took place during Dr. Herbert W. Conn's directorship.

In 1898 Dr. Charles B. Davenport became director of the Laboratory and brought with him a stimulating group of young biologists, thereby notably increasing the extent of the scientific output of the Laboratory. A valuable addition to the physical equipment was made in 1904 by the erection of Blackford Memorial Hall, the gift of Mrs. Eugene Blackford. Other than this, however, growth of physical equipment was not great, for gradually the program of the Brooklyn Institute became so vast, and its immediate interests so localized, in Brooklyn, that finally, with Professor Hooper's death in 1914, interest in the Biological Laboratory fell off considerably. It became apparent that the Laboratory should look elsewhere for a fostering institution or group. The realization of this need was indicated in the raising, in 1917, from residents of the vicinity, of an Endowment Fund of $25,000, the income from which was expected to meet the annual deficit. But this program, though accomplished, was found to be too modest, and in 1924 the Laboratory was transferred from the Brooklyn Institute to the Long Island Biological Assocíaion, with the results which have been noted.

THE COURSE IN PHYSIOLOGY AT THE MARINE BIOLOGICAL LABORATORY

Dr. W. R. Amberson

Professor of Physiology, University of Tennessee
Director of the Course

Dr. Laurence Irving of the University of Toronto and Dr. Margaret Sumwalt of the University of Pennsylvania come to the Physiology Course as new members of the teaching staff. Dr. Irving is lecturing on the physics and chemistry of sea-water, and its biological applications, and is supervising a group of students in a physico-chemical study of sea-water. He is also introducing laboratory work on the salt and H-ion concentration of the body fluids and tissues of fish and invertebrates. Dr. Sumwalt will direct work on cell

permeability and ion balance largely on marine eggs, together with a special section of work on electrical methods in permeability studies.

The system of student election of laboratory work has been continued this year. The laboratory schedule includes eighteen projects, of which each student attempts six or seven only, according to his own selection. The needs and desires of each student are thus taken into account in planning the work.

For the first week, daily lectures are scheduled. In the following three weeks daily lectures will be given, except on Saturday. A series of special lectures is being arranged for the last two weeks in July.

The following lectures have already been given: "The Acid-Base Equilibrium in Sea-Water," Dr. Laurence Irving; "The Fundamentals of Potentiometry as Applied in Physiological Work," Dr. Leonor Michaelis; "The Acid-Base Equilibrium in Sea-Water," and "The Composition of Sea-Water," Dr. Laurence Irving; "Respiratory Pigments," Dr. Alfred Redfield.

Next week the following lectures will be given: June 29: "General Organization of Central Nervous Systems," Dr. Philip Bard; June 30 and July 1: "The Role Played by the Central Nervous System in Posture, Movement, and the Maintenance of Equilibrium," Dr. Philip Bard; July 2: "The Permeability of the Living Cell to Water," Dr. Baldwin Lucke; and July 3: "Cytological Problems of Cell Cleavage," Dr. Henry Fry.

The requirements for admission are an introductory course in biology or zoology and the usual half year course or its equivalent in the embryology of the frog and chick. As the enrollment is limited, admission is of necessity competitive but the primary basis of selection is the ability of the student to profit by the experience of the course and his prospective ability as an investigator. Preference is not necessarily given to those most advanced. It is felt that the most favorable period for attendance often comes after the end of the junior year of the undergraduate and before the close of the second or third year of graduate study, but obviously no arbitrary rule is desirable.

A limited number of students who are well qualified and who propose a satisfactory program of research are allowed to continue after the close of the course without payment of further fees. It also may in some cases be possible to arrange for positions for students as research assistants to some older investigator during the remainder of the summer.

THE COURSE IN EMBRYOLOGY AT THE MARINE BIOLOGICAL LABORATORY

Dr. H. B. Goodrich

Professor of Biology, Wesleyan University

Director of the Course in Embryology

The course in Embryology at the Marine Biological Laboratory aims to provide opportunities for the study of living materials which for the most part are not attainable at universities or colleges. The student is able to see the actual living processes of development usually known to him only from the printed description or from fixed material. This includes such events as the fertilization of the egg, polar body formation, mitosis, cleavage, gastrulation, and many later phases of embryology. He may become familiar with the technique of artificial parthenogenesis, isolation of blastomeres, shifting the cytoplasm by centrifuging, interspecific hybridization, subjecting the egg to varied environments, etc. or may try other experiments that he or the instructor may devise. Twenty to thirty diverse species are available for these varied purposes. The student obtains from these observations a stimulating contact with vital processes that is not otherwise possible and these experiences provide him with a valuable foundation for research and for teaching. This training is most immediately useful in the field of embryology or in those phases of general physiology which utilize embryological material or which deal with isolated living cells, but the general background provided is likely to be of value in almost any realm of biological inquiry. The lectures, in addition to providing the necessary introduction to the observations of the laboratory, are also intended to outline various fields of embryological research. In attaining this purpose great assistance is rendered by those investigators who present to the class the methods and results of their own studies. Many students come from institutions where there is little opportunity for contact with actual investigations or participation in the enthusiasms of the research worker.

DIRECTORY FOR 1931

KEY

Laboratories		Residence	
Botany Building	Bot	Apartment	A
Brick Building	Br	Dormitory	D
Fisheries Laboratory	FL	Drew House	Dr
Lecture Hall	L	Fisheries Residence	F
Main Room in Fisheries Laboratory	M	Homestead	Ho
		Hubbard	H
Old Main Building	OM	Kidder	K
Rockefeller Building	Rock	Whitman	W

In the case of those individuals not living on laboratory property, the name of the landlord and the street are given. In the case of individuals living outside of Woods Hole, the place of residence is in parentheses.

THE MARINE BIOLOGICAL LABORATORY

THE STAFF

Allen, C. E. prof. bot. Wisconsin.
Amberson, W. R. prof. phys. Tennessee.
Bard, P. asst. prof. phys. Princeton.
Bissonette, T. H. prof. biol. Trinity.
Bowling, Rachel instr. zool. Columbia.
Bradley, H. C. prof. phys. chem. Wisconsin.
Brooks, S. C. prof. zool. California.
Calkins, G. N. prof. proto. Columbia.
Cohn, E. J. assoc. prof. physical chem. Harvard.
Cole, E. C. assoc. prof. biol. Williams.
Conklin, E. G. prof. zool. Princeton.
Coonfield, B. R. prof. biol. Southwestern.
Croasdale, Hannah T. "Biological Abstracts". Pennsylvania.
Davis, H. asst. prof. phys. Harvard.
Dawson, J. A. asst. prof. biol. Col. City N. Y.
Duggar, B. M. prof. bot. Wisconsin.
Fry, H. J. prof. biol. New York.
Garrey, W. E. prof. phys. Vanderbilt.
Gerard, R. W. asst. prof. phys. Chicago.
Grave, B. H. prof. biol. DePauw.
Grave, C. prof. zool. Washington.
Goodrich, H. B. prof. biol. Wesleyan.
Hansen, I. B. grad. Chicago.
Harvey, E. N. prof. phys. Princeton.
Hecht, S. prof. biophysics. Columbia.
Hoadley, L. prof. zool. Harvard.
Irving, L. instr. phys. Toronto.
Jacobs, M. H. prof. gen. phys. Pennsylvania.
Jennings, H. S. prof. zool. Hopkins.
Lewis, I. F. prof. biol. Virginia.
Lillie, F. R. prof. zool. Chicago.
Lillie, R. S. prof. gen. phys. Chicago.
Lucke, B. assoc. prof. pathol. Pennsylvania.
McClung, C. E. prof. zool. Pennsylvania.
Mast, S. O. prof. zool. Hopkins.
Mathews, A. P. prof. biochem. Cincinnati.
Michaelis, L. member Rockefeller Inst.
Morgan, T. H. dir. biol. lab. Cal. Inst. Tech.
Nelsen, O. E. instr. zool. Pennsylvania.
Packard, C. asst. prof. zool. Columbia Inst. Cancer.
Parker, G. H. prof. zool. Harvard.
Pollister, A. W. instr. zool. Columbia.
Poole, J. P. prof. evolution. Dartmouth.
Robbins, W. J. prof. bot. Missouri.
Sayles, L. P. instr. biol. Col. City N. Y.
Severinghaus, A. E. asst. prof. anat. Columbia Med.
Sumwalt, Margaret asst. prof. phys. Woman's Med. (Pa).
Taylor, W. R. prof. bot. Michigan.
Twitty, V. C. instr. biol. Yale.
Unger, W. B. asst. prof. zool. Dartmouth.
Wilson, E. B. prof. zool. Columbia.
Woodruff, L. L. prof. proto. Yale.

INVESTIGATORS

Adams, E. M. grad. asst. biol. Cincinnati Med. Br 342. Dr 2.
Addison, W. H. F. prof. histol. and emb. Pennsylvania.
Allee, W. C. prof. zool. Chicago. Br 332. A 106.
Amberson, W. R. prof. phys. Tennessee. Br 309. Quissett.
Anderson, Stella stenographer. "Industrial & Engineer-Chemistry." Br 203. Young, West.
Apgar, Grace M. grad. Pennsylvania. Rock 6. D 211.
Armstrong, P. B. asst. prof. anat. Cornell Med. Br 318. A 105.
Astrom, I. Elizabeth asst. bot. Toronto. Bot. H 4.
Austin, Mary L. instr. zool. Wellesley. Br 217B.
Bailey, P. L. instr. phys. Col. City N. Y. L 28.
Bailey, Sara W. res. asst. biol. Radcliffe. Br 312. Thompson, Main.
Bakwin, H. asst. prof. path. New York. OM 4.
Ball, E. G. instr. phys. chem. Hopkins Med. Br 110.
Baitsell, G. A. prof. biol. Yale. Br 323. Brooks.
Ballard, W. W. instr. zool. Dartmouth. Br 217K. Dr. 1.
Bard, P. asst. prof. phys. Princeton. Br 109. A 301.
Barth, L. G. Nat. Res. fel. Br 111.
Barron, E. S. G. asst. prof. biochem. Chicago. Br 313. D 210.
Beams, H. W. asst. prof. zool. Iowa State. Br 9. Dr 1.
Belkin, M. instr. biol. New York. Br 328. Dr 5.
Benkert, J. M. grad. zool. Pittsburgh. Rock 7. Taylor, East.
Benkert, Lysbeth H. grad. zool. Pittsburgh. Rock 7. Taylor, East.
Bissonette, T. H. prof. biol. Trinity. OM 26. D 108-109.
Bodansky, O. instr. pediatrics. Bellevue Med. OM 4. Broderick, North.
Bostian, C. H. instr. genetics. North Carolina State. Rock 2. D 102.
Bowling, Rachel instr. zool. Columbia. OM 21. A 307.
Boyd, M. J. grad. biochem. Cincinnati. Br 342. Tashiro, Park.
Boyden, Louise E. edit. sec. "Biol. Bull." Harvard Med. Br 305. Young, West.
Bradley, H. C. prof. phys. chem. Wisconsin. Br 122A. Juniper Point.
Bradway, Winnefred E. asst. biol. New York. OM 1. Cowey, Depot.
Bridges, C. res. asst. genetics. Carnegie Inst. (Wash.) Br 324. McLeish, Millfield.
Brinley, F. J. asst. prof. zool. North Dakota State. OM 39. Grinnell, West.
Bronfenbrenner, J. J. prof. bact. Washington Med. (St. Louis) Br 2. Quissett.
Budington, R. A. prof. zool. Oberlin. Br 218. Orchard.
Butt, C. res. asst. Princeton. Br 116.
Calkins, G. N. prof. proto. Columbia. Br 331. Buzzards Bay.
Cannan, R. K. prof. chem. Bellevue Med. Br 310. Gardiner.
Castle, W. A. instr. biol. Brown. Br 233.
Cattell W. res. worker. New York. Br 328. (Cherry Valley).

Chambers, R. prof. biol. New York. Br 328. Gosnold.
Cheever, C. A. retired physician. Bot h. Lewis, Buzzards Bay.
Cheney, R. H. prof. biol. Long Island. OM 45. D 208.
Chidester, F. E. prof. zool. West Virginia. Br 306. D 318.
Christie, J. R. assoc. nematol. U. S. Dept. Agr. Rock 3. Cahoon, Woods Hole.
Clark, Eleanor L. res. asst. anat. Pennsylvania Med. Br 117. East.
Clark, E. R. prof. anat. Pennsylvania Med. Br 117. East.
Cline, Elsie grad. Hopkins. Br 127. W d.
Clowes, G. H. A. dir. Lilly Res. Labs. Br 328. Shore.
Cobb, N. A. principal nematol. U. S. Dept. Agr. Rock 3. F 43.
Cohen, B. M. asst. zool. Hopkins. Br 126. Nickerson, Millfield.
Cole, K. S. asst. prof. phys. Columbia Med. OM 5. D 216.
Cole, R. Oberlin. Br 315. D 216.
Coonfield, B. R. instr. zool. Brooklyn. OM. D 306.
Copeland, M. prof. biol. Bowdoin. Br 334. Gardiner.
Corson, S. A. grad. phys. Pennsylvania. Rock 6. Dr attic.
Costello, D. P. instr. zool. Pennsylvania. Br 217J. Elliot, Center.
Cowdry, E. V. prof. cytol. Washington (St. Louis) Br 223. Millfield.
Croasdale, Hannah T. grad. Pennsylvania. Bot. 22. Hilton, Main.
Culemann, H. W. assoc. prof. biol. Amherst. OM 33.
Curwen, Alice O. instr. histol. Woman's Med. (Pa.) Br 217H. K 12.
Dan, K. grad. Pennsylvania. Br 217. D 217.
Danks, W. B. C. res. officer Dept. Agr. govt. Kenya Colony. Br 224.
Darrah, W. C. paleobot. Carnegie Mus. (Pittsburgh) Rock 7. Hilton, Millfield.
Daugherty, Kathryn res. asst. phys. Pennsylvania. Br 217F. D 211.
Davis, J. E. asst. med. Chicago. Br 313. Hilton, Main.
Davis, J. F. instr. zool. Pennsylvania. OM Base. Dr 6.
Dawson, A. B. assoc. prof. zool. Harvard. Br 312. D 112.
Dodds, G. S. prof. emb. West Virginia Med. Br 222. D 306.
Dolley, W. L. prof. biol. Buffalo. Br 339. A 203.
Donaldson, H. H. member Wistar Inst. Br 115. Buzzards Bay.
Dubois, Anne M. res. asst. emb. Carnegie Inst. (Baltimore) Br 343. D 110.
Dubois, E. F. prof. med. Cornell Med. Br 340. Penzance Point.
Dunbar, F. F. grad. asst. zool. Columbia. Br 333.
Eastlick, H. L. grad. asst. Washington (St. Louis) OM Base. Dr 7.
Edwards, D. J. assoc. prof. phys. Cornell Med. Br 214. Gosnold.
Erlanger, Margaret Harvard Med. Br 108. Young, West.
Failla, G. physicist. Memorial Hosp. (N. Y.) Br 306. Danchakoff, Minot.
Field, Madeline E. res. fel. phys. Harvard. OM Base. H 8.
Fogg, L. C. instr. biol. New York. OM Base. McKenzie, Middle.
Fogg, Mildred C. instr. biol. Hunter. OM Base. McKenzie, Middle.
Fowler, J. R. res. asst. zool. Chicago. Br 332. Erskine, Main.
Francis, Dorothy res. asst. Memorial Hosp. (N. Y.) Br 329.
French, C. S. asst. phys. Harvard. Br 111. Eldridge, Woods Hole.
Furth, J. assoc. pathol. Phipps Inst. L 24.
Fry, H. J. prof. biol. New York. OM Base. Purdum, Woods Hole.
Garrey, W. E. prof. phys. Vanderbilt Med. Br 215. Gardiner.
Geiman, Q. M. grad. proto. Pennsylvania. Rock 6. Cowey, Depot.
Gelfan, S. asst. prof. phys. Alberta. Br 333. Sylvan, Millfield.
Gerard, R. W. assoc. prof. phys. Chicago. Br 309. D 213.
Gilmore, Kathryn grad. zool. Pittsburgh. Rock7. Eldridge, East.
Gilson, L. E. instr. biochem. Cincinnati. Br 341. Tashiro, Park.
Godfrey, A. H. grad. West Virginia. Br 306. Wilde, West.
Goldforb, A. J. prof. zool. Col. City N. Y. Br 122C. Schramm, Gardiner.
Goodrich, H. B. prof. biol. Wesleyan. Br 210. D 316.
Gordon, Gladys secretary. "Industrial and Engineering Chemistry". Br 203. Nickerson, Millfield.
Graham, C. H. Nat. Res. fel. Pennsylvania. Br 231.
Grave, B. H. prof. zool. De Pauw. Br 234. Grave, High.
Grave, C. prof. zool. Washington (St. Louis) Br 327, High
Graubard, M. A. asst. zool. Columbia. OM Base. McInnis, Millfield.
Gray, Nina E. asst. zool. Wisconsin. L 22. Broderick, North.
Green, Arda A. res. fel. phys. Harvard Med. Br 108.
Grundfest, H. Nat. Res. fel. phys. Pennsylvania. Br 232. D 301.
Hall, S. R. res. fel. Harvard Med. L 26.
Hahnert, W. F. Nat. Res. fel. zool. Hopkins. Br 111.
Ham, A. W. instr. cytol. Washington Med. (St. Louis) Br 224. D 101a.
Hamburgh, M. Jr. Hopkins Med. Br 313. Glaser, Gosnold.
Hamburger, R. J. asst. med. clinic. Groningen (Holland) OM 40. Johlin, Park.
Harnly, M. H. asst. prof. biol. New York. Br 1. D 101.
Harnly, Marie L. asst. biol. New York. Br 1. D 101.
Harryman, Ilene res. asst. Lilly Res. Labs. Br 319. D 103.
Hartline, H. K. fel. med. physics. Pennsylvania. Br 231.
Harvey, Ethel B. asst. biol. New York. Br 116. Gosnold.
Harvey, E. N. prof. phys. Princeton. Br 116. Gosnold.
Hayden, Margaret A. assoc. prof. zool. Wellesley. Br 217A. Nickerson, Quissett.
Haywood, Charlotte assoc. prof. phys. Mt. Holyoke. Br 315. A 207.
Heilbrunn, L. V. assoc. prof. zool. Pennsylvania. Br 221. D 315.
Henshaw, P. S. biophysicist. Memorial Hosp. (N. Y.) Br 329. D 206.
Hill, E. S. grad. biochem. Cincinnati. Br 342. Dr attic.
Hill, S. E. asst. phys. Rockefeller Inst. Br 209. Veeder, West.
Hilsman, Helen M. grad. asst. zool. Pittsburgh. Rock 7. Hilton, Millfield.
Hoadley, L. prof. zool. Harvard. Br 312. A 302.
Holbrook, Lucile A. grad. zool. Washington (St. Louis) Br 313. Sylvan, Millfield.
Holt, Helen asst. biol. New York. Br 328. Chambers, Gosnold.
Homes, M. N. asst. bot. Brussels. Br 122A. D 203.
Hook, Sabra J. instr. biol. Rochester. Br 314. K 2.
Hoppe, Ella N. res. asst. biol. N. Y. State Dept. Health. Br 122B. A 305.
Horning, E. S. Sidney. Br 223. D 203.
Howard, Evelyn grad. phys. Pennsylvania. Br 110. Veeder, West.

Howe, H. E. editor "Industrial and Engineering Chemistry." Br 203. West.
Howe, Mary "Industrial & Engineering Chemistry." Br 203. West.
Huettner, A. F. prof. biol. New York. Br 1. Gansett.
Imai, T. asst. biol. Imperial (Sendai, Japan) L 34.
Irving, L. instr. phys. Toronto. Br 109. D 312.
Ishii, K. instr. biochem. Jikei-kai Med. (Tokyo) Br 122. Tashiro, Park.
Jacobs, M. H. prof. gen. phys. Pennsylvania. Br 102. Minot.
Johlin, J. M. assoc. prof. biochem. Vanderbilt Med. Br 336. Park.
Johnson, D. S. prof. bot. Hopkins. Br 118. A 101e.
Johnson, H. H. Col. City N. Y. Br 315.
Katz, J. grad. biol. New York. OM Base. Avery, Main.
Keil, Elsa M. instr. zool. N. J. Col. Women. Br 8. W e.
Keltch, Anna K. res. asst. Lilly Res. Labs. Br 319. Duffus, Millfield.
Kidder, G. W. grad. zool. Columbia. Br 314. D 307.
Kille, F. R. assoc. prof. biol. Birmingham Southern. OM 1. D 307.
Kindred, J. E. assoc. prof. emb. Virginia Med. Br 106. D 202.
Kinney, Elizabeth T. lect. zool. Barnard. Br 217. K 3.
Knower, H. M. assoc. prof. anat. Albany. Br 334. Buzzards Bay.
Knowlton, F. P. prof. phys. Syracuse Med. Br 226. Gardiner.
Lackey, J. B. prof. biol. Southwestern. Br 8. A 108.
Lambert, Elizabeth F. tech. Harvard Med. Br 107. Young, West.
Larrabee, M. G. Harvard. Br 231. Beal, Bay View.
Lillie, F. R. prof. zool. Chicago. Br 101. Gardiner.
Lillie, R. S. prof. gen. phys. Chicago. Br 326. Gardiner.
Liljestrand, P. H. Ohio Wesleyan. Br 216. Dr 3.
Lucas, A. M. asst. prof. cytol. Washington Med. (St. Louis) Br 224. Mast, Minot.
Lucas, Miriam S. instr. cytol. Washington Med. (St. Louis) Br 224. Mast, Minot.
Lucke, B. assoc. prof. path. Pennsylvania. Br 311. Minot.
Lund, E. J. prof. phys. Texas. Br 206. A 208.
Lynch, Ruth S. instr. genetics. Hopkins. Br 127. D 201.
McClung, C. E. prof. zool. Pennsylvania. Br 219. A 201.
McGoun, R. C. instr. biol. Amherst. Br 204. Dr 6.
McGregor, J. H. prof. zool. Columbia. Br 301. Elliot, Center.
Mann, D. R. grad. asst. Duke. OM Base. Hall, High.
Marsland, D. A. asst. prof. biol. New York. Br 315. D 106.
Mathews, A. P. prof. biochem. Cincinnati. Br 342. Buzzards Bay.
Mavor, J. W. prof. biol. Union. Br 304. Bar Neck.
Medaris, D. De Pauw. Br 217I. K 7.
Meltzer, A. Cornell Med. Br 217L Dr 1.
Metz, C. W. prof. cytol. Carnegie Inst. Wash. and Hopkins. Br 343. Hyatt.
Michaelis, L. member Rockefeller Inst. Br. 207. Danchakoff, Gansett.
Miller, Helen M. Nat. Res. fel. Hopkins. Br 126. D 105.
Mitchell. P. H. prof. phys. Brown. Br 233. Orchard.
Morgan, F. H. prof. biol. Cal. Inst. Tech. Br 320.
Morgan, Lillian V. Cal. Inst. Tech. Br 320.
Morgulis, S. prof. biochem. Nebraska Med. Br 313. D 308.
Morrill, C. V. assoc. prof. anat. Cornell Med. L 27. Country Club Inn, (West Falmouth).
Morris, S. instr. zool. Pennsylvania. Rock 6. D 310.
Nabrit, S. M. prof. biol. Morehouse. L 33. A 104.
Navez, A. E. lect. gen. phys. Harvard. Br 122A.
Newton, Helen ms. editor "Industrial & Engineering Chemistry." Br 203. Young, West.
Nicholas, W. W. physicist. Bureau Standards.
Nicoll, P. A. grad. asst. biol. Washington (St. Louis) OM Base. Dr 7.
Nonidez, J. F. assoc. prof. anat. Cornell Med. Br 318. Whitman.
Packard, C. asst. prof. zool. Columbia Inst. Cancer. OM 2. North.
Papenfuss, G. F. grad. bot. Hopkins. Bot 4. Frawley, Main.
Parker, G. H. prof. zool. Harvard. Br 213. Elliot, Center.
Parkinson, Nellie A. asst. ed. "Industrial & Engineering Chemistry." Br 203. Young, West.
Parks, M. E. asst. instr. biol. New York. OM Base. Avery, Main.
Parmenter, C. L. assoc. prof. zool. Pennsylvania. Br 220. D 204.
Parpart, A. K. instr. phys. Pennsylvania. Br 205. D 302.
Parpart, Ethel R. asst. biol. Long Island. Br 205. D 302.
Patch, Esther M. asst. anat. Long Island. OM 1. Googins, Quissett.
Payne, F. prof. zool. Indiana. Br 122D. A 202.
Peebles, Florence prof. biol. California Christian. L 30.
Pierce, Madelene E. Radcliffe. Br 217E. Kittila, Bar Neck.
Plough, H. H. prof. biol. Amherst. Br 204. Agassiz.
Pollister, A. W. instr. zool. Columbia. OM 44. D 314.
Pollister, Priscilla F. instr. zool. Brooklyn. OM 44. D 314.
Pond, S. E. asst. prof. phys. Pennsylvania. Med. Br 216. Gansett.
Poole, J. P. prof. evolution. Dartmouth. Bot 25. D 305.
Raffel, D. Nat. Res. fel. Hopkins. Br 125. D 201.
Redfield, Helen Cal. Inst. Tech. Br 320. D 301.
Reese, A. M. prof. zool. West Virginia. Br 222. D 206.
Rempe, A. E. tech. Washington. Br 224. Cowey, Depot.
de Renyi, G. S. assoc. prof. anat. Pennsylvania. Br 114. D 215.
Reznikoff, P. instr. med. Cornell Med. Br 340.
Richards, O. W. instr. biol. Yale. Br 8. D 317.
Rijlant, P. B. L. prof. phys. Brussels. Br 225. D 212.
Risley, P. L. instr. zool. Michigan. L 21.
Robinson, E. J. grad. asst. New York. OM Base. Avery, Main.
Root, C. W. asst. biochem. Princeton. Br 110. Cowey, Depot.
Root, W. S. asst. prof. phys. Syracuse Med. Br 226. Spaeth, Whitman.
Rosensteel, Eva G., secretary. Br 223. A 306.
Rugh, R. instr. zool. Hunter. Br 217M.
Sayles, L. P. instr. biol. Col. City N. Y. OM 25. D 214.
Schauffler, W. G. physician. Princeton. L 23.
Schechter, V. asst. zool. Col. City N. Y. Br 122C. Dr 2.
Schluger, J. res. asst. biol. New York. Br 1. McLeish, Millfield.
Schmidt, L. H. res. fel. biochem. Cincinnati Med. Br 341. Tashiro, Park.
Schrader, F. prof. zool. Columbia. Br 330. (Gansett).
Schrader, Sally H. res. worker cytol. Columbia. Br 330. (Gansett).
Schultz, J. Carnegie Inst. (Wash.) Br 232. D 301.
Schweitzer, M. D. grad. asst. zool. Columbia. Br 314. McLeish, Millfield.
Scott, A. C. grad. asst. zool. Pittsburgh. OM 43. K 10.
Scott, Florence M. asst. prof. biol. Seton Hill. Br 217D.
Shapiro, H. grad. asst. zool. Columbia. Br 314. Dr 10.
Shaw, C. Ruth Pittsburgh. Rock 7. H 9.
Sichel, F. J. M. grad. asst. biol. New York. Br 337. Dr 2.

Sickles, Grace asst. bacteriol. N. Y. State Dept. Health. Br 122.
Slifer, Eleanor H. Nat. Res. fel. zool. Iowa. Br 217G. Kittila, Bar Neck.
Smith, Helen B. grad. res. zool. Hopkins. Br 343. Gray, Buzzards Bay.
Smith, M. Doreen res. asst. prev. dentistry. Toronto. L 32. H 2.
Snook, T. instr. histol. and emb. Cornell. L 29. Dr 2.
Sonneborn, T. M. res. assoc. genetics. Hopkins. Br 127. D 111.
Southwick, W. E. grad. emb. Harvard. OM Base. Lyons, Woods Hole.
Speidel, C. C. prof. anat. Virginia. Br 106. D 104.
Stancati, M. F. grad. asst. zool. Pittsburgh. Rock 2. Hilton, Millfield.
Stockard, C. R. prof. anat. Cornell Med. Br 317. Buzzards Bay.
Street, Sibyl asst. zool. Vassar. Br 8. McLeish, Millfield.
Strong, O. S. prof. neur. and neurohistol. Columbia Med. Br 8. Elliot, Center.
Sturdivant, H. P. instr. zool. Columbia. Br 314. D 207.
Sumwalt, Margaret asst. prof. phys. Woman's Med. (Pa.) OM 3. D 209.
Tang, P. S. res. fel. phys. Harvard. Br 309. D 107.
Tashiro, S. prof. biochem. Cincinnati. Br 341. Park.
Taylor, W. R. prof. bot. Michigan. Bot 24. Whitman.
Tittler, I. A. grad. asst. zool. Columbia. Br 314. Dr 10.
Titus, C. P. director. Sch. of Microscopy (N. Y.) OM Base. Avery, Main.
Torvik-Greb, Magnhild grad. asst. biol. Pittsburgh. Rock 7. H 9.
Turner, J. P. instr. zool. Minnesota. Br 217N.
Twyeffort, L. H. grad. Princeton. Br 111. Lyons, Woods Hole.
Unger, W. B. asst. prof. zool. Dartmouth. OM 22. D 218.
Van Alstyne, Margaret res. asst. med. Harvard. Br 213. Grinnell, Bar Neck.
Van Slyke, E. instr. zool. Pittsburgh. Rock 7. K 10.
Wade, Lucille W. De Pauw. Br. 319. Robinson, School.
Wald, G. grad. asst. biophysics. Columbia. OM Base. McLeish, Millfield.
Walker, Ruth I. instr. bot. Wisconsin. Bot 5. Broderick, North.
Warren, H. C. prof. psychol. Princeton. Br 303. Bar Neck.
Weelans, Anna A. secretary. Princeton. Br 303. A 205.
Weisman, M. N. tutor. Col. City N. Y. OM 34. K 15.
Welty, C. asst. prof. biol. Parsons. Br 332. Taylor, East.
Whitaker, D. M. asst. prof. zool. Columbia. Br 333. Morgan, Buzzards Bay.
Whiting, Anna R. prof. biol. Pennsylvania Col. Women. OM 46. Whitman.
Whiting, P. W. assoc. prof. zool. Pittsburgh. OM 46. Whitman.
Wilde, Mary H. grad. asst. bot. N. J. Col. Women. Bot. Prentiss, Millfield.
Wilson, E. B. Da Costa prof. emeritus zool. Columbia. Br 322. Buzzards Bay.
Wilson, Hildegard N. grad. asst. biochem. New York Med. Br 310. Buzzards Bay.
Winsor, Agnes A. assoc. biol. Hopkins. L 25. (Cataumet).
Winsor, C. P. assoc. biol. Hopkins. L 25. (Cataumet).
Witschi, E. prof. zool. Iowa. Br 9. A 201.
Wolf, E. A. asst. prof. zool. Pittsburgh. OM 43.
Woodward, A. E. asst. prof. zool. Michigan. L 21. K 3.
Young, Roger A. asst. prof. zool. Howard. Br 228. A 304.

STUDENTS

Adell, J. C. grad. Columbia. proto. Nickerson, Millfield.
Alderman, Evangeline grad. asst. Wellesley. emb. W a.
Alexander, L. E. grad. Michigan. emb. K 14.
Alexanderson, Amelie M. Bryn Mawr. emb. K 2.
Altland, Clair S. grad. asst. biol. American. bot. K 7.
Andrew, Barbara L. grad. asst. bot. Alabama. bot. K 8.
Auringer, J. grad. Detroit City. proto. Dr 15.
Barney, R. L. prof. biol. Middlebury. phys. Glover. Ransom (Quissett).
Beck, L V. grad. asst. phys. New York. phys. McLeish, Millfield.
Boone, Eleanor S. grad. asst. zool. Stanford. emb. Nickerson, Millfield.
Brown, Rebecca R. grad. Columbia. proto. K 12.
Bryan, Hilah F. grad. Smith. bot. Robinson, Quissett.
Buchheit, J. R. grad. asst. biol. Illinois. emb. Dr 6.
Buck, M. Anna Maine. emb. K 8.
Burr, Edith R. grad. Columbia. proto. Gray, Buzzards Bay.
Cable, R. M. grad. fel. New York. emb. Cowey, Depot.
Carlson, J. G. instr. biol. Bryn Mawr. emb. K 7.
Carpenter, Helena J. fel. biol. Ohio Wesleyan. proto. W e.
Chase, H. grad. Howard. emb.
Chen, H. T. Harvard. emb. Dr 9.
Coulter, Edith A. Goucher. emb. W b.
Dee, M. Barbara grad. zool. Boston. proto. Eldridge, Woods Hole.
Denny, Martha grad. Radcliffe. emb. Kittila, Bar Neck.
Derrickson, Mary B. Syracuse. emb. W e.
Dick, G. A. prof. vet. med. Pennsylvania. emb. D 204.
Ericson, Alma L. grad. biol. Columbia. proto. H 7.
Eskridge, Lydia C. tech. asst. Hopkins. proto. W e.
Fenton, Frances E. Connecticut. proto. H 7.
Fisher, K. C. asst. biol. Acadia. phys. McLeish, Millfield.
Gaetjens, Laura C. Elmira. phys. White, Millfield.
Green, D. E. asst. zool. New York. phys. McLeish, Millfield.
Heiss, Elizabeth M. grad. asst. biol. Purdue. phys. W g.
Henderson, Lillian O. instr. biol. H. Sophie Newcomb. proto. Erskine, Woods Hole.
Hunt, W. L. Southwestern. bot. Berg, School.
Hutchings, Lois M. teacher biol. Barringer H. S. proto. H 8.
Ickes, Marguerite teacher biol. Lincoln H. S. (Cleveland). proto.
Jackson, J. R. grad. asst. Missouri. bot. Dr 2.
James, Miriam E. teacher biol. Gloucester H. S. (Mass.) proto. Grinnell, West.
Kaston, B. J. grad. asst. biol. Yale. emb. (Martha's Vineyard).
Lundstrom, Helen M. grad. res. fel. dental surgery Pennsylvania. phys. H 3.
McQuesten, Barbara grad. Radcliffe. phys. Nickerson, Millfield.
Magruder, S. R. grad. Cincinnati. emb. Kittila, Bar Neck.
Michaelis, Eva M. grad. chem. Barnard. phys. Danchakoff, Gansett.
Moore, Caroline Pennsylvania. bot. H 6.
Moore, Elinor grad. Pennsylvania. phys. H 6.
Morgan, Isabel M. Radcliffe. phys. Buzzards Bay.
Newcomer, A. Virginia grad. Radcliffe. emb. Kittila, Bar Neck.
Noll, C. I. grad. asst. chem. Trinity. phys. Cowey, Depot.
Oppenheimer, Jane M. Bryn Mawr. emb. H 7.
Ormsby, A. A. grad. Detroit City. proto. Dr 15.
Perry, Lily M. grad. Shaw Sch. of Bot. Washington. bot. Young, West.
Plyler, Phyllis V. asst. biol. Goucher. emb. W b.

Price, J. B. asst. biol. Stanford. emb. Dr 14.
Prosser, C. L. grad. asst. phys. Hopkins. phys. Dr 5.
Reid, Marion A. instr. phys. Boston Med. phys. Robinson, Quissett.
Sawyer, Elizabeth L. instr. zool. Maine. emb. Avery, Main.
Scherp, H. W. grad. chem. Harvard. phys. Robinson, Quissett.
Sell, J. P. Oberlin. emb. K 5.
Shea, Margaret M. grad. Wellesley. emb. W a.
Smith, W. F. Jr. Cornell Med. emb. McInnis, Millfield.
Sperry, Helen A. instr. biol. Cathedral Sch. of St. Mary (N. Y.) proto. Robinson, Woods Hole.
Stewart, P. A. Rochester. proto. K 6.
Sweetman, H. L. asst. prof. ent. Mass. State. phys. Higgins, Depot.
Townsend, Grace instr. biol. Joliet Jr. emb. H 4.
Walker, P. A. grad. Bowdoin. emb. Thompson, Main.
Watkins, Evelyn G. Vassar. proto. Eldridge, East.
Weed, M. R. grad. asst. biol. Wesleyan. emb. K 5.
Willard, W. R. Yale Med. phys. Dr 2.
Woodruff, Beth H. grad. asst. biol. Western Reserve. emb. W d.
Woodside, G. L. asst. biol. DePauw. emb. K 7.

ADMINISTRATION

Billings, Edith secretary. Millfield.
Crowell, Polly L. asst. to the business manager. Main.
Dillinger, Bessie R. secretary. W i.
Finch, Kathleen secretary. H 2.
MacNaught, F. M. business manager. School & Millfield.

LIBRARY

Blanchard, Hazel assistant. W g.
Bradbury, Hester A. assistant. W h.
Lawrence, Deborah secretary. Locust (Falmouth).
Montgomery, Priscilla B. librarian. Whitman.
Rohan, Mary A. assistant. Millfield.

CHEMICAL ROOM

Deitrick, J. E. grad. Hopkins Dr 5.
Frew, Pauline Bates. W f.
Geib, Dorothy grad. Hopkins.
Hale, J. B. grad. Illinois. Grave, High.
Johlin, Sally Oberlin. Gardiner.
Keil, Elsa M. instr. zool. N. J. Col. for Women. W e.
Lackey, J. B. prof. biol. Southwestern. A 108.
Richards, O. W. (in charge chem. room) instr. biol. Yale. D 317.
Street, Sybil asst. zool. Vassar. McLeish, Millfield.
Strong, O. S. (director chem. room) prof. neur. and neurohist. Columbia. Elliot, Center.

APPARATUS ROOM

Apgar, A. R. photographer. D 110.
Boss, L. F. mechanician. Middle.
Graham, J. D. glass-blowing service. Veeder, Millfield.
Liljestrand, P. H. Ohio Wesleyan. assistant. Dr 3.
Pond, S. E. asst. prof. phys. Pennsylvania. custodian. Gansett.

SUPPLY DEPARTMENT

Clarkson, W. deckhand. Water.
Crowell, Ruth S. secretary. Main.
Crowell, P. S. Harvard. collector and chauffeur. School.
Erlanger, H. Wisconsin. collector. Dr 3.
Gray, G. M. curator research museum. Buzzards Bay.
Gray, M. collector. (Teaticket).
Hilton, A. M. collector. Millfield.
Kahler, W. collector. East.
Leathers, A. W. head shipping dept. Minot.
Lehy, J. collector and chauffeur. Millfield.
Lewis, E. M. engineer Cayadetta. Buzzards Bay.
Lillie, W. collector. Gardiner.
McInnis, J. resident manager. Millfield.
Nielsen, Anna M. secretary. Glendon.
Poole, Marjery G. bot. collector. D 304.
Smith, C. B. Hamilton. collector. Dr 3.
Staples, S. Harvard. collector. Dr 3.
Thornley, W. Dartmouth. collector.
Veeder, J. J. captain Cayadetta. Millfield.
Wamsley, F. W. supervisor of schools, Charleston. special preparator.
Wilcox, G. G. collector. Dr 3.
Wixon, R. fireman. (Falmouth).

BUILDINGS AND GROUNDS

Callahan, J. janitor. OM N wing. Dr 4.
Cornish, G. janitor. Br 1st floor. Dr 4.
Goffin, R. T. Jr. iceman. Millfield.
Googins, H. janitor. Quissett.
Hemenway, W. carpenter. carpenter shop. Hawthorne. (Falmouth Heights).
Hilton, H. A. superintendent of buildings and grounds. carpenter shop. Thompson, Water.
Keltch, R. janitor. Br 3rd floor. Millfield.
Look, G. janitor. OM S wing. Quissett.
McInnis, F. M. janitor. Bot & L. Millfield.
McManus, J. janitor. Br 2nd floor. Dr 4.
Rock, J. F. N. emergency man. Dr 4.
Russell, R. L. gardener.
Russell, M. R. night watchman
Swain, G. Jr. janitor. Br 3rd floor. Main (Quissett).
Tawell, T. E. storekeeper and head janitor. basement Br. Thompson, Water.

MECHANICAL DEPARTMENT

Carty, F. night mechanic. Br 7. K 7.
Kahler, R. assistant. Br 7. Macbeth, East.
Larkin, T. superintendent. Br 7. Woods Hole.

DOMESTIC HELP

Ashe, Helen K. Bates. Ho 202.
Birkitt, Dorothy K. N. J. Normal (Glassboro). Ho 204.
Brown, Bertha C. Ho 111.
Buckley, Katherine Ho 101.
Colby, Anna Ho 203.
Collins, Mary C. Ho 210.
Coombs, L. Ho 2.
Coombs, Nellie in general charge. Ho 12.
Duest, Virginia Ho 203.
Downing, Florence E. Ho 205.
Downing, Isabelle L. in charge dining room. Ho 201.
Fischer, L. Boston. Ho 106.
Green, Angie B. N. J. Normal (Glassboro). Ho 202.
Hookstra, Ruth U. N. J. Normal (Glassboro). Ho 204.
McDougall, Mary Ho 207.
McGrath, Mary Broderick, West.
Mulford, Kathryn H. N. J. Normal (Glassboro). Ho 204.
Nordstrom, K. chef. Ho 6.
Pease, Annie Ho 211.
Percival, Mina N. Ho 102.
Pereira, J. R. Suffolk Law (Boston). Ho 107.
Pond, Luella Dr.
Porteous, W. Ho 108.
Russell, Helen E. Ho 212.
Shea, Katie Ho 112.
Steele, N. Dr.
Temple, I. Ho 7.
Tuttle, P. School of Fine Arts (Boston). Ho 106.
Welch, Hattie Ho 105.
Welch, Hattie Ho 105.
Wester, Gertrude Ho 203.
Weymouth, D. N. School of Fine Arts (Boston). Ho 2.
Young, Grace West.
Young, Virginia Maine. Ho 202.

U. S. BUREAU OF FISHERIES

INVESTIGATORS

Bailey, E. W. jr. aquatic biol. U. S. B. F. (Cambridge) Oceanographic Inst. 108. F 49.
Bateman, C. B. lab. mechanic. U. S. Dept. Agr. (Wash.) F 55.
Bearse, H. M. jr. aquatic biol. U. S. B. F. (Cambridge) 138. Wiles, Gardiner.
Bigelow, R. P. prof. zool. Mass. Inst. Tech. M 2 Gardiner.
Brown, F. A. Jr. Austin teaching fel. zool. Harvard. 123. F 50.
Buhrer, Edna M. jr. nematologist. U. S. Dept. Agr. M. Lehy, Millfield.
Cable, Louella E. jr. aquatic biol. U. S. B. F. (Beaufort, N. C.) Hatchery and M. 31. F 31.
Chesley, L. C. grad. fel. phys. Duke. 151. F. 41.
Cobb, N. A. prin. nematologist. U. S. Dept. Agr. M. F 43.
Conger, P. diatomist. U. S. Nat. Museum (Wash.) 141. F 47.
Cooper, Corinne jr. nematologist. U. S. Dept. Agr. M. Sydell, Glendon.
Crossman M. Louise jr. nematologist. U. S. Dept. Agr. M. Sydell, Glendon.
Danforth, Josephine F. illustrator. U. S. Dept. Agr. M. Lehy, Millfield.
Foster, K. W. instr. biol. Tufts. M. F 54.
Galtsoff, Eugenia assoc. zool. George Washington. 122. F 26.
Galtsoff, P. S. in charge oyster investigations. U. S. B. F. (Wash.) 122. F 26.
Goffin, Catherine E. Brown. 119. Millfield.
Goffin, R. biol. U. S. B. F. 115. Millfield.
Hall, F. G. prof. zool. Duke. 149. Hamblin, High.
Herrington, W. C. haddock invest. U. S. B. F. (Cambridge) 140. F 45.
Imlah, Helen W. grad. Radcliffe. M. Kavanagh, High.
Jaffe, Ernestine grad. Wellesley. 139. Goffin, Millfield.
Jenkins, G. B. prof. anat. George Washington Med. 1. Clough, Millfield.
Kumin, H. grad. Antioch. 146. F 50.
Linton, E. fel. Pennsylvania. M 5. West.
Lynn, W. G. instr. comp. anat. Hopkins. 123. F 48.
Milch, Erna L. secretary. U. S. B. F. (Cambridge) 118.
Moses, Mildred S. asst. U. S. B. F. (Cambridge) 146. Agassiz.
Nesbit, R. A. asst. aquatic biol. U. S. B. F. (Cambridge) M 6. F 47.
Neville, W. C. asst. U. S. B. F. 119. Greene, Millfield.
Sandground, J. H. curator of helminthology. Harvard. M 3. F 44.
Sette, O. E. the director. in charge North Atlantic Fishery Investigation. U. S. B. F. (Cambridge) 118. F.
Smith, R. O. asst. aquatic biol. oyster investigations. U. S. B. F. (Wash.) 122.
Swanger, Helen H. jr. nematologist. U. S. Dept. Agr. M. Lehy, Millfield.
Taylor, G. W. grad. Princeton. M. F 48.
Tipton, S. R. fel. phys. Duke. 149. F 41.
Turner, J. P. instr. zool. Minnesota. 217n. Grinnell, West.
Webster, J. R. jr. aquatic biol. U. S. B. F. (Cambridge) 140. F 49.
Wilson, C. B. head science dept. Mass. State Normal Sch. (Westfield) M 4. F 44.
Worley, L. G. Austin teaching fel. zool. Harvard. M. F 54.

BUILDINGS AND GROUNDS

Armstrong, J. S. engineer. "Phalarope". Glendon.
Bosworth, Edith C. secretary. 117. Millfield.
Bosworth, W. R. V. fisherman. "Phalarope". Millfield.
Brown, S. 3rd. museum attendant. FL 136.
Cassidy, H. L. carpenter. Woods Hole.
Conklin, P. S. fireman. machine shop. High.
Hamblin, R. P. apprentice fish culturist. hatchery. Nye (Falmouth)
Hoffses, G. R. superintendent 117. F.
Hosmer, H. Jr. museum attendant. FL 136.
Howes, E. S. cockswain. hatchery. Water.
Howes, W. L. fish culturist. 116. Millfield.
Lowey, J. E. engineer. machine shop. Glendon.
Morrison, D. cook. "Phalarope". "Phalarope".
Radil, A. H. apprentice fish culturist. Hatchery. FL 134.
Reynolds, J. seaman. "Phalarope". "Phalarope".
Snow, C. B. fireman. machine shop. FL 135.
Veeder, R. N. master "Phalarope". West.
Webster, H. M. fireman. machine shop. FL 137.

OCEANOGRAPHIC INSTITUTION

Allan, K. B. grad. Clark. 213.
Beach, E. F. Brown. 110. Hilton, Water.
Beale, Alice grad. emb. Radcliffe. 108. Thompson, Main.
Bigelow, H. B. the director. curator oceanography. Museum Comp. Zool (Cambridge). 114. Luscombe, Main.
Borodin, N. A. Museum Comp. Zool. (Cambridge) 107.
Brooks, C. F. prof. Clark. 213.
Burbank, C. B. Harvard. "Asterias".
Church, P. E. grad. Clark. 213.
Clarke, G. L. Museum Comp. Zool. (Cambridge). 212. "Atlantis".
Emmons, G. grad. Harvard. 207. (Monument Beach).
Ingalls, Elizabeth Harvard Med. 102.
Iselin, C. 2nd asst. curator oceanography. Museum Comp. Zool. (Cambridge) 208. "Atlantis".
Montgomery, R. Harvard. "Atlantis".
Mosby, O. U. S. Coast Guard Ice Patrol Base 5.
Rakestraw, N. W. asst. prof. chem. Brown. 110. Wilson, Woods Hole.
Reuszer, H. W. grad. Rutgers. 201.
Rossby, C. G. A. assoc. prof. Mass. Inst. Tech. 207. Wilde, Gardiner.
Sears, Mary grad. zool. Radcliffe, 108. F 32.
Seiwell, Gladys E. Brown. 211. Larkin, Woods Hole.
Seiwell, H. R. curator oceanography. Buffalo Museum Science. 211. Larkin, Woods Hole.
Stetson, H. C. asst. curator paleontology. Museum Comp. Zool. (Cambridge) 105. "Neva".
Waksman, S. A. microbiologist N. J. Agr. Experiment Station (New Brunswick) 201.
Walker, Virginia B. secretary to director. Museum Comp. Zool. (Cambridge) 112. Howes, Millfield.
Warbasse, E. Antioch. 201. Penzance.
Warner, W. S. Jr. Harvard. "Asterias".
Weed, R. H. Harvard. "Asterias".
Welsh, J. H. Museum Comp. Zool. (Cambridge) 207, 215. Clough, Millfield.
Wolfe, Mary F. lab. technician zool. Harvard. 105. Kittila, Bar Neck.
Ziegler, Virginia asst. to William Beebe, New York. 106. White, Millfield.
Zucker, J. M. Brown. 110.

NATIONAL RESEARCH COUNCIL

Barnum, Susie G. assistant. Br 120. H 1.
Johnson, D. S. chairman div. biol. and agr. Br 120. A 101.
McGraw, Miss Br 120. H 1.

THE COLLECTING NET

A weekly publication devoted to the scientific work at Woods Hole.

WOODS HOLE, MASS.

Ware Cattell .... Editor

Assistant Editors

Margaret S. Griffin Eleanor Brown
Annaleida S. Cattell

The Collecting Net in 1931

The purpose of THE COLLECTING NET is to assemble material which is of especial interest to the workers in the biological institutions at Woods Hole. We want to record as fully as we can the research work and other activities of the members of the Marine Biological Laboratory, the United States Bureau of Fisheries and the Woods Hole Oceanographic Institution. But we also want to seek relevant material outside of Woods Hole and to record local events of interest. The projected editorial contents of our magazine can be divided fairly well into the four parts:

(1) Results of scientific work reported during the summer at Woods Hole, together with critical reviews of such reports.

(2) Items reporting the activities of members of the scientific institutions in Woods Hole.

(3) World-wide news of the activities of individuals working in the field of biology.

(4) The more important local news.

THE COLLECTING NET is an independent publication. Its contents are based primarily on the three scientific institutions in Woods Hole, but it has no official connection with any one of them.

We believe that there is not only a place but a real need for an informal magazine of biology which is prepared to include constructive discussion on any topic of interest to those persons working in the field of the biological sciences.

The fact that THE COLLECTING NET is responsible to no organization gives it a peculiar advantage over many other publications in the field of science. It can include material that they would hesitate to print. Editors often have an article that they would like to print, but cannot because some editorial board or organization would have to assume responsibility for it.

We therefore wish to make it known that we welcome material of this kind and that we are ready to reproduce in black and white many things pertaining to the administration of universities and scientific institutions which one often hears but rarely reads.

Beach Restrictions

Two recent cases of the assertion of property rights, the limitation of the bathing space on the bayside beach and the courteously formulated request of the Trustees of the Forbes estate, call the attention of the scientific institutions in Woods Hole to the need of safeguarding and developing recreational facilities.

It is natural and desirable that laboratory workers should hope to profit from the physical advantages of their environment. It is certainly true that some investigators, even among those who have acquired property, are beginning to feel that Woods Hole is likely to become less desirable for themselves and their families unless recreational facilities can be retained and expanded. Is there, for example, any surety that the bathing beach frontage may not be limited to that of a single lot or even lost entirely if efforts are not made to place the bathing beach under public or institutional control? The Marine Biological Laboratory has shown foresight in providing real estate for the summer homes of investigators and it now seems desirable that attention should be paid to these recreational needs before it is too late.

The regular meetings of the Penzance Sunday Forum will be held on Sunday afternoon at four o'clock at Gladheim on Penzance Point, beginning July 5th. These meetings are an established institution and have been held for the past twenty years. All teachers and students at the laboratories, as well as other interested persons, are invited. Social, economic and scientific matters of current interest are discussed in an informal way. At the first meeting on Sunday, July 5th, Mr. Roger Baldwin will speak about our civil liberties.

Currents in the Hole

At the following hours (Daylight Saving Time) the current in the hole turns to run from Buzzards Bay to Vineyard Sound:

July 2	6:38	6:47
July 3	7:23	7:35
July 4	8:09	8:21
July 5	8:58	9:13
July 6	9:45	10:10
July 7	10:32	11:03

In each case the current changes approximately six hours later and runs from the Sound to the Bay. It must be remembered that the schedule printed above is dependent upon the wind. Prolonged winds sometimes cause the turning of the current to occur a half an hour earlier or later than the times given above.

ITEMS OF INTEREST

Dr. C. G. Rogers, professor of comparative physiology at Oberlin College, who has been located in the Oberlin Room in the Laboratory for many years, resigned from the staff of the embryology course of the Marine Biological Laboratory. After spending the summer at Oberlin, he sails early in September for Europe where he will spend his sabbatical yar.

Dr. Hope Hibbard, associate professor of zoology at Oberlin, has gone to Europe for the summer. She will spend most of her time in Russia, Austria, France and Germany.

Dr. V. C. Twitty of Yale, who was on the staff of the embryology course last year, is now holding a National Research Fellowship at the Kaiser-Wilhelm Institute at Berlin.

Henry B. Bigelow, Jr., sailed from Montreal on June 26th, for England. He will return about September 1 as an able-bodied seaman, on the *Atlantis*.

Dr. and Mrs. Frank Knowlton have gone to Syracuse, New York, to see their daughter, Miss Katherine Knowlton, who has just returned from a trip to California. They will return to Woods Hole at the end of next week.

Dr. Hans Spemann of the University of Freiburg, a prominent European embryologist, will visit Woods Hole during the latter part of this summer.

Dr. and Mrs. J. M. Johlin and daughters, Ruth Ann and Sally, of Nashville, have deserted the Laboratory Apartments this year for their new home off Gardiner Road. Miss Sally Johlin will work in the chemical room of the laboratory for the summer.

Dr. S. Tashiro and family are living in their new house on Park Street, off Gardiner Road.

Mr. J. A. Gilmore, collector in the Supply Department two years ago, made a short visit to Woods Hole during the week of June 8th before returning to Dartmouth to be graduated. He will attend the Iowa Law School this summer.

During the last few years the Bureau of Fisheries has released thousands of drift bottles off the North Atlantic coast of the United States. An extremely interesting return has just come in from the 1929 release, from a bottle picked up at Fairfield Crooked Island, the Bahamas. Judging from previous distant drifts this bottle was carried eastward across the North Atlantic and southerly on the eastern Altantic and then again to the westward, being cast up in the Bahamas after floating about two years.

Dr. Paul Galtsoff, in charge of oyster investigations at the Bureau of Fisheries, attended the Pacific meetings of The American Association for the Advancement of Science, which were held in Pasadena, California, from June 15th to June 20th. He read a paper at the symposium on oceanography, entitled "The Life in the Ocean from a Biochemical Point of View." Among the many interesting symposiums were those of genetics and photosynthesis. Over twelve hundred registered members of the association were present.

Dr. O. E. Sette, director of the Bureau of Fisheries, left in the *Albatross* on June 12th for the Virginia capes. The trip covered about fifteen hundred miles. Dr. Sette was in charge of the scientific work ,and William O. Neville and Frank E. Firth assisted. The object of the trip was to look for the early stages of mackerel eggs and larvae in the various plankton forms. The party returned on June 18th. Temperatures and water samples were taken, in order to determine the oceanic conditions that influence the development of the various pelagic plants and animals. An abundance of the late mackerel larvae was found in the southern half of the region covered. In the northern half of the region, earlier stages were found, as well as a great abundance of *Calanus*, one of the most important food members of the plankton. Collections have been brought back to the Fisheries laboratory for detailed examination. Along the western edge of the continental shelf, forty or fifty miles off shore, a Portuguese man-of-war was spotted—the first to be seen this spring.

The M. B. L. Club again invites your attention to the facilities of its club house. You will find there an opportunity for quiet relaxation, for reading current periodicals, for playing cards, for meeting old friends and for making new ones, etc.

The opening dance was held on Saturday. As heretofore, there will be a dance every Saturday evening. The radio amplified phonograph which used to provide music for dancing has been improved since last year, and it is hoped it may again be used for repeating some of the splendid concerts of last year.

A new raft has been built and is ready for those who enjoy water sports.

Every member of the laboratory is invited to join the club and to give it their support.

THE WOODS HOLE LOG

The United States Coast Guard located at Woods Hole leads an adventurous life in the service of the government and the community patrolling the waters from Old Harbor on the outside of the Cape to the Sakonnet River.

During the past week two fishing boats went aground off Gay Head. The Coast Guard came to the rescue. One of them, *The Constellation*, had had her bottom ripped out. The crew were rescued and fed at the base and Mr. Cahoon then provided them with transportation back to Boston. The other was salvaged in spite of the fact that there was quite a blow on, and as the engine wouldn't go, the Coast Guard towed her to New Bedford where she could undergo repairs.

Just at present Commander Patch has a mystery to solve. Three or four days ago a Mr. Howard Rynard reported that his boat, a green sloop thirty-six feet long, numbered C-7076, had been taken without permission and he asked the Coast Guard for aid in recovering her. A little later, a green sloop was reported off No. 2 Buoy in Hyannis. She was full of water and when the Coast guard finally got her off they found that she was numbered C-7076. Maskus Seralis who was in charge of the sloop when she went aground, was arrested as a suspicious character on Tuesday. Now the owner has disappeared, and nobody by the name of Rynard can be located.

Although Commander Patch is constantly pestered by people who miss the last boat and wish transportation, he can not, of course, comply with such requests unless the circumstances are unusual. Last Fall, however, a gentleman on Nantucket was seriously ill, and as a final measure to save his life, two blood donors were coming down from Boston. The boats were not running so Commander Patch, warned by the Doctor of the arrival of the two Bostonians, came to the fore and transported them over to the island.

The Coast Guard was also of invaluable aid last Fall in checking the terrific forest fires near Hatchville, and one of their men had his eye dangerously burned.

The garden of Gladheim, the Woods Hole home of Dr. and Mrs. James Peter Warbasse of Brooklyn, was the scene on Sunday, June 21st. of the marriage of their daughter, Miss Agnes Warbasse to Mr. Harvey Willard Burger, son of Mr. and Mrs. Harvey Plumstead Burger of Brooklyn. The Rev. Leslie Wallace of Falmouth performed the ceremony. Miss Vera Warbasse was her sister's only attendant. Mr. James Peter Warbasse Jr. was best man and the ushers were Messrs. Richard Northrup and Eric Price Warbasse, brothers of the bride. After a short trip the couple will live in Brooklyn.

Swimming and life saving lessons will be given free again this summer in Woods Hole to children and adults under the auspices of the American Red Cross, with Miss Ruth Mullaney of Hyannis as instructor. The schedule of lessons at the Breakwater Beach is as follows:

July 1 at 10 A. M.
July 2 at 10:30 A. M.
July 3 at 11 A. M.
July 11 at 4 P. M.
July 25 at 4 P. M.

The first half hour will be devoted to beginners and the remainder of the time to advanced swimming and life saving. Registration blanks may be obtained from Mrs. Thomas Larkin, chairman of the Red Cross.

The Woods Hole Choral Club had its first meeting in the M. B. L. Club Tuesday, June 23rd, after the lecture. The Club is beginning its fifth season under the leadership of Professor Ivan Gorokhoff. Rehearsals are scheduled for Tuesday and Friday evening after the lecture. All those who like to sing are cordially invited to see Mr. Gorokhoff before or after the rehearsal.

We took the Old Silver Beach road last week to the University Players' Theatre where, amid an array of boxes and cans of paint, the Players were beginning to get things organized for their fourth season.

Composed primarily of men and women from the Colleges and Universities who are striving for the development of a more imaginative and a more craftsmanlike American theatre, the Players are adhering more and more rigidly to professional standards. This year every member of the company is specially trained in his particular field, and their ambitious schedule calls for such Broadway successes as "Paris Bound," "Coquette," "Her Cardboard Lover," "The Trial of Mary Dugan," "The Guardsman," and "Juno and the Paycock."

THE COLLECTING NET

Vol. VI. No. 2 | SATURDAY, JULY 4, 1931 | ANNUAL SUBSCRIPTION, $2.00 SINGLE COPIES, 25 CTS.

THE MT. DESERT ISLAND BIOLOGICAL LABORATORY

DR. HERBERT V. NEAL
Director of the Laboratory

The Mt. Desert Island Biological Laboratory was founded at South Harpswell, Maine, in 1898 by John Sterling Kingsley, who was one of the first to appreciate the need of a marine biological station north of Cape Cod. The Laboratory was incorporated in 1913 and later—in 1921—moved to Salisbury Cove on Mt. Desert Island. At present it has two stations, the Weir Mitchell Station at Salisbury Cove and the Dorr Station at Bar Harbor. Research workers only are admitted to the former, while field courses as well as opportunities for research are offered at the latter.

The facilities of the Laboratory are adequate for thirty research workers. The property of the Laboratory includes over one hundred acres of land, five small wooden laboratory buildings with wharf, runway and float, a social center and dining hall, two cottages, tents with wooden platforms, three motor boats, etc The laboratories are (*Continued on Page* 40)

OSTEOCLASTS AND CHONDROCLASTS

DR. G. S. DODDS
Professor of Embryology, School of Medicine, West Virginia University

The large multinucleate cells, known as osteoclasts, which are so common in red bone marrow are commonly believed to be the agents in the destruction of bone tissue during the development and growth of bones. There has also been a belief on the part of some students that these same cells have an important part in the destruction of preliminary cartilage which precedes the bone in the process of endochondral ossification, though this view has not been widely accepted. The following observations upon growing bones of dogs and cats have a bearing on this question.

It was observed in the developing bone, where the marrow is encroaching upon the cartilage and the cartilage cells are arranged in longitudinal rows, that the calcification of the cartilage matrix does not effect the transverse walls between the cells of a row, but only the longitudinal walls between rows in the invasion of the

M. B. L. Calendar

TUESDAY, JULY 7, 8:00 P. M.

Evening Seminar. Dr. A. C. Redfield, "Effect of Hydrogen Ion Concentration and Salt Concentration on the Oxygen Dissociation Constant of Hemocyanin."

Dr. Laurence Irving, "The Co_2 Dissociation Curve of Living Mammalian Muscle."

Dr. E. N. Harvey, "Photo-electric Records of Animal Luminescence."

FRIDAY, JULY 10, 8:00 P. M.

Evening Lecture. Dr. G. H. Parker, professor of zoology, Harvard University, "Humoral Agents in Nervous Activities with Special Reference to Chromatophores."

TABLE OF CONTENTS

marrow into this tissue are broken down and the cartilage cells liberated, apparently under the influence of the smaller cells of the marrow (the primitive connective tissues cells or the vascular tissue). No osteoclasts are present in the tongues of marrow which advance along the rows of cells. On the other hand, it was constantly observed that where the longitudinal walls of calcified matrix are undergoing destruction, osteoclasts are very abundant ,and are commonly seen wrapped about free edges of such spicules. Thus the calcified part of the tissue is destroyed by a different agency than the non-calcified portions. This same relation was also seen in the nests of cells found in epiphyseal centers and in the earliest beginning of the center of ossification, when the marrow first enters the cartilage from the periosteum. In each case the uncalcified portions of the matrix are removed without the presence of osteoclasts, while calcified material is destroyed, apparently only under the influence of osteoclasts.

The studies indicate that there is no one type of cell to which the name chondroclast can be given, and that osteoclasts do not confine their activity to bone tissue, but rather to calcified matrix, whether of cartilage or bone.

REVIEW OF THE SEMINAR REPORT OF DR. DODDS

DR. ARTHUR W. HAM

Instructor in Cytology, Washington University

Dr. Dodds has made an excellent point in indicating that there is no one type of cell to which the name chondroclast can be given. His work shows that in the developing bone the multinucleate cells arise as the osteogenic cells and blood vessels invade the calcified cartilage, and that the osteoclasts only form about the calcified matrix. It is interesting to compare this process with that seen in the healing fracture. In the latter the osteogenic cells of the periosteum and endosteum are found to differentiate into both cartilage and bone, and as healing progresses the cartilage is replaced by bone in much the same manner as that seen in developing and growing bone, except that there is no arrangement of the cartilage cells in columns. The cartilage is not replaced until the cells have become mature and the matrix calcified. When this occurs, signs of degeneration make their appearance in the cartilage cells, and on occasion, lacunae coalesce before the invasion of blood vessels and osteogenic tissue. Soon, however, through the passages created by the breaking down of the rather thin walls of the lacunae, the tissue is invaded by osteogenic cells and blood vessels. The former differentiate into osteoblasts which form bone on the surface of the remnants of the calcified cartilage matrix, and into osteoclasts, which form about portions of cartilage matrix not covered by new bone, and about portions of the newly formed bony trabeculae. There is no evidence to show that the osteoclasts are instrumental in opening up the cartilage lacunae as a previous step to the invasion of osteogenic cells and blood vessels. On the other hand, it is quite evident in a study of healing fractures that the formation of osteoclasts is somewhat secondary to the invasion of the cartilage.

It is significant, as Dr. Dodds has noted, that the calcified material calls forth the formation of osteoclasts. On the other hand, it is very evident that calcified material is a profound stimulus to new bone formation, a point which is well illustrated by the formation of metaplastic bone about areas of pathological calcification. It therefore appears that calcified material incites two types of responses, one which results in osteoclasts and the other in osteogenesis. It is not unreasonable to conclude that the osteoclast response is in the nature of a foreign body type of reaction. The osteoclasts are not strongly phagocytic and they refuse to take up vital stains. Hofmeister indicated that they, because of their non-specific property of elaborating carbon dioxide in the course of their metabolism, caused solution of the calcium salts in the calcified material adjacent to them. It is obvious that resorption of bone is often accomplished without their assistance, as in creeping replacement, tumor invasion and under the influence of pressure. Furthermore, in instances of hypercalcaemia induced by either hyperparathyroidism or hypervitiminosis (D), the calcium salts may be removed from bone matrix in wholesale fashion. In these conditions, however, it is not uncommon to find conditions similar to giant cell tumor and osteitis fibrosa cystica developing, an observation which on the surface appears to indicate again that the osteoclasts in these conditions are formed as a result of calcium removal rather than as the primary cause of it.

Although it seems definite that osteoclasts are called forth by the presence of dead calcified matrix, and that the histological evidence is indicative of their playing some part in its removal by liberating some substance causing a solution of the calcium salts, their importance in bone and

calcified cartilage destruction should not be overestimated because the process often occurs without their assistance. Their powers are not unique as other cells on occasion advance readily into calcified matrix. Although they arise from osteogenic cells, they tend to form about almost any type of calcified material if it is placed in contact with the osteogenic tissue, so that although they are called osteoclasts they are really not specific for bone. Consequently in view of the lack of specificity on the part of the osteoclast, it is obvious that there is less evidence to support the hypothesis that presumes the existence of a specific destroyer of cartilage, and that the use of the term chondroclast only aggravates an already complicated situation.

PASSAGE OF SPERMS AND EGGS THROUGH THE MAMMALIAN OVIDUCT

Seminar Report of Dr. G. H. Parker
Director of the Zoological Laboratory, Harvard University

Summarized by Dr. Alfred M. Lucas
Assistant Professor of Cytology, Washington University

The vertebrate oviduct performs the interesting mechanical feat of conducting objects in two directions: the sperms toward the ovary and the ova toward the uterus. The oviducts of certain reptiles and birds possess a ciliary organization particularly adapted to perform this function, in that there exists in these animals a narrow proovarian tract for the conduction of sperms upward and an extensive abovarian tract for the propulsion of ova downward. In mammals, however, the effective stroke of all cilia is toward the uterus.

The interval of time required for the completion of various phases related to reproduction are quite constant in the rabbit, which makes this animal well suited for studies on the mechanism of sperm and egg movement. The passage of sperms from the vagina to the uterus is more rapid than could possibly be accomplished alone by their swimming movements. It is apparent that muscular contractions of the region concerned must aid in the propulsion of sperms toward the oviduct. This conclusion is supported by the experiments of Lim and Chao (1927), in which a segment of rabbit uterus was reversed, and yet fertilization and implantation was obtained. The passage of sperms upward through the oviduct has generally been conceived as a rheotactic response to the ciliary current which is directed downward. This opinion is supported by the experiment of Adolphi (1905), in which sperms placed between slide and cover-glass oriented themselves to a current of fluid passed over them. It has been observed, however, that the heads of the sperms are somewhat sticky and the tendency to adhere causes them to be orientated against a stream in a fashion similar to that of a weathervane. Sections of the rabbit's oviduct were removed and slit open longitudinally. Sperms, suspended in Ringer's solution, which were added to the preparation, were carried downward with the current produced by the cilia. They remained unoriented. This evidence of rheotaxis is lacking.

Small quantities of ink injected into the lumen about mid-way between the two ends of the uterine tube ultimately appeared both in the uterus and on the fimbriae. When introduced into the tube near either end the ink appeared at the opposite end. The ink particles have no motility of their own, yet some of them arrive at the ovarian end of the tube against the ciliary current.

Muscular movements of a tpye similar to the segmentation in the intestine are known to take place and have been observed in the uterine tube. The several contractions occurring simultaneously divide the lumen temporarily into a series of compartments. The numerous branched ribbonlike folds which form the walls of the tube present surfaces largely covered by cilia. The current produced passes downward between the opposed faces of the folds. Since the lower end of the compartment is closed a return current is initiated which passes upward through the center of the lumen. Sperms, ink particles or other objects which may lie in this central stream are carried upward by it toward the upper end of the segment. The next succeeding rhythmic contraction cuts the compartment in two parts, the upper half of which together with the lower half of the segment above forms a new closed compartment. The same process being repeated, it is only a matter of a sufficient number of contractions before material which floats in the axial stream is carried to the upper end of the tube. Likewise, objects which lie close to the walls and come under the direct influence of the ciliary beat will by the same muscular mechanism reach the uterine end of the tube. The motility of the sperms, therefore, has no direct relation to its conduction through the uterine tube.

The egg of the rabbit has a diameter of about

0.18 mm. and this size is such in relation to the size of lumen and folds of the tube that the cilia may most effectively propel the ovum toward the uterus. The egg lying between two adjoining folds presses against their surfaces and it is well known that mechanical stimulation increases the effectiveness of ciliary movement.

Sobotta, as well as others, regards the absence of ciliated cells from the uterine end of the mouse oviduct as indicating that peristaltic contractions of the muscular layers are responsible for the propulsion of the ovum. The experiments of Lode, Grosser, and others led them to regard the cilia as the motile agents.

This study is of particular interest to the gynecologist in his interpretation of hemorrhagic cysts of endometrical type. The histological examination of so-called chocolate cysts led Sampson (1922) to conclude that they are derived from fragments of uterine epithelium which somehow have been carried through the tube into the body cavity. The present work would indicate that the uterine cells follow the same course as the ink particles and the sperm.

REVIEW OF THE SEMINAR REPORT OF DR. PARKER

Dr. Alfred M. Lucas

Assistant Professor of Cytology, Washington University

The extensive studies which have been made upon the muscular movements in the uterus and oviduct of mammals have resulted in a tendency to minimize the importance of the function of the ciliated epithelium lining the Fallopian tube. Conclusions based upon recent studies might lead to the belief that cilia serve no other function within the mammalian tube than that of a "sweeper" for the purpose of removing cellular fragments and debris from the walls of the tube. Some regard the antiperistaltic contractions as adequate for the upward conduction of sperms. Earlier investigations, however, such as those of Kehrer, Pinner, Heil, Lode, Grosser, and others represent cilia as important agents in the propulsion of sexual products.

The interesting experiments and deductions made by Dr. Parker suggest a correlation between ciliary and muscular movements in the oviduct of the rabbit. The muscular contractions in this case render the ciliary movement effective in the upward conduction of sperms. Dr. Parker has shown how it is possible for sperms to be conducted upward through the system and ova to be carried downward toward the uterus without a change in direction of ciliary movement.

The controversial question can only be solved when direct observations are made upon the mammalian tube *in situ*. Since it has been possible to observe ciliary movement through the oviduct wall *in situ* in rats and guinea pigs it is reasonable to anticipate possible direct observation upon the movement through the oviduct of larger objects such as sperms and ova.

THE MOUNT DESERT ISLAND BIOLOGICAL LABORATORY

(Continued from Page 37)

supplied with running fresh and salt water, electricity for light, heat and power, and the usual apparatus for biological research. The library contains most of the American journals.

Mount Desert Island is situated on the coast of Maine, one hundred miles east of Portland. Its cold waters are extraordinarily rich in marine life, including forms found on rocky surf-beaten shores, in muddy coves, on the sea bottom at a multitude of depths and conditions, and floating on the surface of bays, inlets, and open sea. Depths of over a hundred fathoms are found within twenty miles, where Salpa, Staurophora, Tomopteris, Siphonophores, and hundreds of other pelagic forms are found on the surface in their season. The deep bottoms furnish brachiopods, huge actinians, basket stars, Boltenias, and many other rare forms. Cerebratulus and the echinoderm Echinarachnius are abundant and furnish ripe eggs for study in the summer. The large holothurian, Pentacta, sea-urchins, and several starfish are extremely abundant and of large size.

In addition to its marine fauna, the island has a range of bold, deeply divided, ice-eroded mountains that form a belt across its southern half. Their lower sides are clothed by forests, and between their peaks, rising at highest over 1500 feet, are lakes, streams, and marshes with a rich fresh-water fauna. Several of these lakes are large and deep; one of lesser size is 1100 feet above the sea. Brooks are abundant and of cold water, containing trout and a great variety of northern fresh-water invertebrates.

Besides being situated in a region of great beauty, unspoiled by commercial exploitation or nearness to large cities, the Laboratory has the advantage of being placed in close

contact with the wild-life Sanctuary of Acadia National Park, created recently on Mount Desert Island by the United States through the efforts of a group of its public-spirited summer residents. This is the only National Park in the eastern portion of the continent and the only one in the country in direct contact with the sea. This secures for all time a permanent and singularly rich area for biologic study in every field, vertebrate and invertebrate.

For the season of 1931 thirty research workers have engaged rooms at the Weir Mitchell Station and ten students are enrolled in field courses at the Dorr Station. Among the research workers are: Professor William H. Cole of Rutgers University, Professor Ulric Dahlgren of Princeton, Professor Defrise of the University of Milan, Dr. Allan Grafflin of Harvard University, Dr. Percy L. Johnson of Johns Hopkins University, Professor Margaret L. Hoskins of New York University, Professor Abram T. Kerr of Cornell University, Dr. and Mrs. Warren H. Lewis of the Carnegie Institution, Dr. C. C. Little of the Jackson Memorial Laboratory, Professor E. K. Marshall, Jr. of Johns Hopkins University, Professor Samuel O. Mast of Johns Hopkins University, Frank J. Myers of the American Museum, Dr. D. M. Pace of Duke University, Professor Herbert V. Neal ofTufts College, Professor E. A. Park of Johns Hopkins University, Professor C. C. Plitt of the University of Maryland, Professor Harold R. Senior of New York University, Dr. Homer W. Smith of New York University, Professor William Wherry of Cincinnati University.

During the present season public lectures will be given by Ulric Dahlgren, Warren H. Lewis, C. C. Little, E. K. Marshall, Jr., Kirtley F. Mather and Herbert V. Neal.

A seminar on the researches carried on at the Laboratory is held weekly during the season.

At the Dorr Station work on problems of college undergraduates or graduate grade is open to a limited number of students. Mt. Desert Island is peculiarly fitted for work of this sort. Forms for study among the insects, arachnids, fishes, amphibians, birds, and mammals are plentiful and varied. The work is conducted under supervision of a general rather than of a detailed nature, aiming to develop in the student individuality and an appreciation of the value of field work in natural history. While not neglecting laboratory methods, it attempts to focus major interest on problems of behavior or ecology in the field. The large number of species of bird life on or near Mt. Desert Island makes possible unusual opportunities for field study. Work in the field includes investigation of the distribution, resting habits, and other interesting phases. Opportunity for a limited number of advanced undergraduates or graduate students to take up personal problems under the direction of the staff of the Roscoe B. Jackson Memorial Laboratory at Bar Harbor is also offered. The problems center about the work of cancer research being carried on at that laboratory.

Those wishing to come to the Mt. Desert Island Biological Laboratory may come by rail from New York or Boston by the Bar Harbor express which brings them directly to Ellsworth on the mainland where they will be met by the Laboratory car. The connections by water from Boston are excellent and less expensive the Boston and Bangor Steamship line leaving Boston every evening and connecting at Rockland in the early morning with a Bar Harbor boat, which passes through the beautiful Fox Island Thoroughfare, among the spruce-clad islands of the Maine coast, and arrives at Bar Harbor about noon. Or it is permitted to remain on the Bangor steamer until the boat reaches Bucksport, Maine, from which a steamer bus runs to Bar Harbor. Those coming to the Laboratory should notify the Director in advance, so that they may be met on arrival by the Laboratory car.

Board for those connected with the Laboratory and their families is provided at the Laboratory dining hall in Salisbury Cove at $10.00 per weeek. Rooms at reasonable prices may be found in the village of Salisbury Cove, or tents may be rented for the summer from the Laboratory.

Applications for rooms in the Weir Mitchell Station should be addressed to Herbert V. Neal, Salisbury Cove, Maine. Inquiries in regard to admission to courses in Field Natural History should be sent to Clarence Cook Little, Jackson Memorial Laboratory, Bar Harbor, Maine.

George Sylvester Viereck, novelist, is staying at The Breakwater for the summer. His many interesting volumes include:— "My First Two Thousand Years—The Wandering Jew", "Salome —My First Two Thousand Years of Love", and "Flesh and Blood". He has traveled extensively and during the World War became noted for the stirring articles he wrote.

THE COURSE IN INVERTEBRATE ZOOLOGY AT THE MARINE BIOLOGICAL LABORATORY

Dr. James A. Dawson
Assistant Professor of Zoology, College of the City of New York
Director of the Course

The course in Invertebrate Zoology at the Marine Biological Laboratory has been in existence now for over forty years. During this time a few accounts of the work of this course have been published. The account given by Allee[1] gives a resume of its history and development up to the year 1922. The writer, who at present is in charge of the course, has been a teaching member of the staff since 1919 and has thus been actively connected with the course for the last twelve years. From 1922 to 1925, inclusive, Dr. R. H. Bowen was the instructor in charge and the present writer has held that position from 1926 to the present time. The staff who have collaborated in the writing of this account have all served at least three years of this five year period. While the general organization of the course has remained practically the same as it was during 1922, a number of changes in the nature of the work have been made and it is proposed to deal briefly with these in this account.

Applications for admission to this course during the period under consideration have been each year from 60 to 100% in excess of the number (54) which could be accepted. Selections have been made in accordance with the policy of the Laboratory which is clearly outlined each year in the Announcement. Thus young graduate students and seniors who have the announced intention of doing investigation in Zoology have made up the greater part of the student body in the course during the last few years. With such a large application list and with nearly every applicant at least technically qualified for admission the task of selection has become increasingly difficult. It is felt, however, that the class selected each year drawn largely from the eastern half of the United States is representative of the students showing most research promise.

The presentation of the subject material includes as in the past the various phyla of invertebrate animals from the Protozoa to the Chordata exclusive of the Vertebrata. The modifications and new developments in the course will be given in this order. Special developments in certain groups and features dealing with the work of the class as a whole will be presented at the end of the treatment of the phyla.

Protozoa: As usual two days are spent on this phylum and in addition the first field trip of the course is taken on the Saturday of the opening week. For this trip the class is divided into two groups of four teams each. Each of these groups collects from at least four different habitats. The collections made by the whole class are then assembled and studied as will be described later.

In the laboratory work on protozoa the aim has been to present to the students specimens of the chief classes or sub-phyla of this phylum. The protozoan fauna of the Woods Hole region is peculiarly rich since great variation in protozoan habitats, including fresh, brackish and salt water, can be had in the space of a relatively short work. For the sake of completeness and to obtain as much contrast as possible the first day's work is devoted to a study of fresh and brackish water species while the second day is given over exclusively to marine species. During the past three years students have studied, chiefly with the aid of the low power of the compound microscope, subcultures of two species of common, large, free-living amebae. These cultures are prepared in Syracuse Watch Glasses a few days previous to the time they are to be studied in accordance with a method worked out by the writer[2] and thus contain organisms in a normal active growing condition. Optimum conditions are thus afforded for the study of the activities, e.g., locomotion, food capture and ingestion and even fission of the presumably best known protozoans. Students are asked to record their observations so that they can later identify each species when referred to accurate descriptions. Results recorded for the past few years show that a relatively small number of the class make sufficiently thorough diagnoses to enable them to identify correctly the organisms. It is felt that time so spent is fully justified when it is realized that the common, free-living amebae have specific differences which are generally not known by the majority of zoologists due largely to the lack of opportunity for comparison. Cultures of the representative but somewhat rare ciliate Blepharisma undulans and of the heliozoan, *Actinosphaerium,* are also studied in the

same way. A number of other representative forms, all obtained from the vicinity of Woods Hole, are invariably present in the laboratory for students who wish to increase their knowledge of well known species which are not usually studied in college laboratories. During the second day marine species are studied. Students are taught the method of finding and studying not only such free living forms as the Suctoria of the region but also the less well known parasitic species such as *Haplozoon clymenellae*, the parasitic dinoflagellate from the annelid, *Clymenella torquata*, and the gregarine, *Schizocystis sipunculi* from the gephyrean worm, *Phascolosoma gouldii*.

Field work with the protozoa is carried on during the first Saturday of the course. All species taken at a given habitat during the morning field trip are kept together in clean glass dishes. The entire afternoon is spent in identifying such species as the combined efforts of the class and instructors can accomplish. Determinations of the pH of the water from each habitat have been made during the last three years and the motile phase of different protozoans has been studied. The list of protozoa which have been identified is on record and gives an interesting and valuable picture of the protozoan fauna of this region.

Porifera: There has been no change worthy of comment in the work on Porifera during the years under consideration.

Coelenterata and *Ctenophora:* In general, treatment of these phyla varies slightly from year to year due to the variation in seasonal growth of the coelenterates and ctenophores of the region. Representatives of the genera mentioned in Allee's account are available for study by the class. Living *Aurelia* are obtainable about every other year. Unfortunately the typical ctenophore of the region, *Mnemiopsis leidyi*, has in the past been present only during the closing part of the course. Living specimens of this species are studied after field trips at that time. Since 1929 the course has begun in August and as a result all of the previous difficulties in regard to living ctenophores have been removed. Unfortunately some of the better known hydroids such as *Tubularia* are no longer available at this time; this is compensated for by the fact that *Pennaria*, usually very scarce early in July, is at its period of greatest abundance during August.

Platyhelminthes, Nemertinea, Nemathelminthes and *Trochelminthes:*

The treatment of these phyla has undergone extensive modification since 1922. As in the previous groups the schedule of study is rather elastic. Due to the diverse preparation of the class, consisting as it does of selected advanced students, every opportunity is given for individual work; only very general directions are made and students are advised to select their material in such a way as to gain the most extensive acquaintance possible with the functions, structures and habits of these animals.

In the laboratory work on Platyhelminthes the following studies are suggested. (1) The study of the role of cilia and muscles in locomotion using the fresh-water triclads, *Planaria maculata, Phagocata gracilis* and *Dendrocoelum lacteum;* the marine triclads, *Bdelloura candida* or *Syncoelidium pellucidum* (both from the gill books of *Limulus)* and *Procerodes wheatlandi,* also the marine acoele *Polychoerus caudatus.* (2) The mechanics of proboscis action; the single pharynx of *Planaria* and the multiple pharynges of *Phagocata* are observed as they are extruded under the influence of 7% ether water. (3) Feeding experiments. (4) Morphology of living specimens of *Bdelloura* or *Syncoelidium* including observation of the flame cells. (5) Regeneration experiments. If, as frequently happens, the student has already performed such experiments on Planaria, he is advised to do more extensive experiments in regeneration or to carry on a comparative study of this in several species. *Planaria foremanni* is especially favorable for this work, its dark color contrasting sharply with that of the unpigmented regenerating tissue. (6) Demonstrations of egg capsules and newly hatched young of various species.

Laboratory work on the Trematodes includes (1) Morphology of living *Pneumonoces vibex*, a fluke found commonly in the pharynx of the puffer, *Spheroides maculosa.* (2) Sporocysts of different ages are obtained by stirring vigorously the crushed bodies of 50 or more mud-snails *(Alectrion obsoleta)* in sea water, decanting off half the liquid and examining the material which settles out of it. The older stages contain *Cercarium lintoni* which has apparently no redia stage. (3) Rediae are obtained in quantity from the liver of the European periwinkle *(Litorina littorea)* in certain regions, particularly those most frequented by gulls around Woods Hole; these contain developing cercariae. (4) For cercariae, the tailless *Cer-*

carium lintoni may be used or the more typical and active cercaria from *Litorina littorea.*

Laboratory work on the Cestoda is essentially as described by Allee (1922, pp. 105-107). (1) In addition, however, to the study of the scolices of the living *Rhynchobothrium bulbifer* and *Calliobothrium verticillatum* from the spiral valve of the smooth dogfish, study is made of preserved scolices of *Taenia, Moniezia,* etc., as well as of *Thysanocephalum* and other marine tapeworms. (2) The mature proglottids of *Rhynchobothrium,* a parasite of the dogfish as sand sharks are no longer sufficiently common about Woods Hole to provide a dependable source of living *Crossobothrium.* (3) The eggs, discharged when a "ripe" proglottid is placed in a dish of sea water. (4) Embryos of *Rhynchobothrium* following the plan instituted by Bowen in 1921 (Allee, 1922, p. 106).

Nemertinea: Prior to 1927 the little nemertean *Tetrastemma,* commonly found in pile scrapings, was studied each year for about half a day. In 1927 this exercise was discontinued in favor of a study of the free-living nematodes of the region although a few students each year have studied *Tetrastemma.*

Nemathelminthes: Laboratory work involves the study of various free-living marine genera, especially *Oncholaimum,* from beach sand a short distance below tide level. The sand is washed in pans under a swift stream of seawater whereupon the lighter organic material consisting of varied assortments of protozoa, worms, crustaceans, etc., is decanted off and concentrated. These nematodes because of their abundance, transparency and resistance to the pressure of a cover glass are most satisfactory objects for study, even under oil immersion. They possess, moreover, extensive structural modifications not seen in the parasitic forms which are the only nematodes familiar to most of the class. Through the courtesy of Dr. N. A. Cobb, senior nematologist of the U. S. Department of Agriculture, and his staff, living and fixed specimens of many other common nematodes of the Woods Hole region have been demonstrated. In 1927 and 1928 the class has been fortunate in hearing a special illustrated lecture on the Nematoda by Dr. Cobb.

Echinodermata: The Echinoderms, with no fresh water representatives, present material which can be studied satisfactorily only in a marine laboratory. The first day of laboratory work on living starfish includes in addition to dissection, a study of the details of locomotion, righting reactions and movements of isolated arms. By class discussion these studies are correlated with the work of Jennings[3], Cole[4], and Hopkins[5]. Class observations confirm and question many points made by these workers. Comparative studies of methods of locomotion are also made upon members of the Ophiuroidea, Echinoidea and Holothuroidea. These studies are suggestive of the different factors upon which the evolution of the different classes may have turned. The experiments of Parker[6] on the movements of the sand-dollar, *Echinarachnius* are repeated and help to bring into discussion the theory of a return of bilateral symmetry upon a secondarily imposed asymmetry. Experiments to test the nature of the adhesive power of the tube feet (Cf. Paine[7]) are carried out. Members of different classes of echinoderms are used for a comparative study of the cell content of the perivisceral fluid. The work of Kindred[8] is followed in some detail. The phagocytic nature of the coelomic cells is observed by microscopic study of the coelomic fluid 12 hours after injection of 10 cc. of a carmine suspension. Coelomic fluid is obtained according to the method given by Allee, 1922, page 107.

During the second day and part of the third the study of Arbacia includes the special study of Aristotle's lantern as an instrument of mastication, respiration and locomotion (Gemmill, 1912[9]). The study of the embryology of the starfish is deferred until the third day since experience has shown that the problem of the unique metamorphosis with changes of symmetry, polarity and body axis becomes clearer to the student after a study of the adult structure. The embryological material is obtained by following Dr. C. Smith's schedule[10]. In order to prepare the cultures it is necessary to have a large supply of mature male and female starfish. At this time, July 15, (according to the class schedule for the years preceding 1929) the average number of such starfish is about 1 to 2 in 30 animals. This difficulty has been overcome by having the laboratory assistant select and save mature specimens for two weeks beforehand. Condition of the gonad is determined by removing an arm and making a microscopic study to determine percentage of fertility of the eggs. From such mature specimens cul-

tures are started and maintained. Mature females thus tested and kept in an aquarium have been seen to take the umbrella position and to extrude clouds of mature eggs. This process may be stimulated to occur by introducing strong sperm suspensions into the aquarium. Such a starfish if removed to a crystallizing dish will continue to give off mature eggs for about half an hour and from these eggs the best cultures are obtained. Normal shedding of eggs does not frequently occur under laboratory conditions but factors which favor this process are at a maximum when selected females are stimulated.

On the last day of laboratory, students study *Leptosynapta* and *Thyone* independently. The technique for securing anaesthetized *Thyone* has been improved by using a carefully prepared and specially kept chloretone solution. A chloretone solution made saturated by heating and kept in a bottle filled to capacity to prevent volatilization retains the concentration of chloretone. If 15cc of such a solution is inoculated into a living fresh *Thyone* the animal relaxes in half an hour and the tentacles may be forced out by gentle manipulation. In work on the echinoderms experience has shown that the interest of the class is best secured by the discussion and repetition of recent investigation of animals of this phylum.

Annelida: Since this group illustrates how a simple body plan may be highly modified in various habitats, the laboratory work is introduced by a comparative study of the external features and activities of a series of living worms. For this purpose the following were selected: *Nereis Virens, Glycera, Lepidonotus, Diopatra, Amphitrite* and *Hydroides.* The specimens are placed in large crystallizing dishes containing fresh sea water and the students are asked to make a study of variations in cephalization, modifications in the parapodia, various types of movements and to correlate their observations with the habitats in which the worms live. The method used by Copeland[11] with *Nereis* is employed in the study of these annelids. Each student is furnished with short pieces of glass tubing of suitable size and asked to find out which of the specimens will enter the tubes. It is found that both *Nereis* and *Diopatra* will usually enter the tubes and remain there. When the worm is in the tubes students can easily distinguish between respiratory and locomotor movements. In the case of *Diopatra* the method of tube building is easily seen. Shortly after *Diopatra* enters a glass tube it secretes a layer of mucus around the body, attaches this to one end of the glass tube and then rotates. In this manner a mucus tube is produced which immediately invests the body. Particles of seaweed, shells, etc., are taken by the worm and cemented to the end of the glass tubing. In a number of instances worms built an extension of an inch or more on the end of the glass tubing in the course of a day.

In addition to a study of the structure of typical annelids of the region, e.g., *Nereis, Glycera, Arenicola,* etc., a comparative study of the parapodia of *Nephythys, Nereis virens, Glycera dibranchiata, Arabella opalina* and *Diopatra cuprea* is made. Thus a series ranging from the uniramous to the completely biramous condition is studied and at the same time the modification of parapodia in different parts of the body is noted. (Material for this study is prepared in accordance with instructions left by Dr. R. H. Bowen.) The worms are hardened and segments are cut off with a sharp scissors. These are dehydrated in alcohol and cleared with oil of wintergreen.

A concluding study of development is made of the larvae of *Hydroides* and *Nereis limbata* as well as of the brood pouch of *Spirorbis.*

Bryozoa: Live polypides, cystids, ovicells, avicularia and spines of *Bugula flabellata* are compared with those of *Bugula turrita.* Ciliary action and feeding reactions are also studied on these animals as types of endoproct Bryozoa. *Barentsia sp.,* a typical endoproct is obtained by suspending glass slides in racks from the eel pond float for about three weeks. An especial effort is made during the day to have students familiarize themselves, by study of zooarial features, with such erect or stolonate forms as *Aetea, Crisia, Bowerbankia* and with encrusting forms, as *Lepralia, Schizoporella, Membranipora* and *Flustrella,* all of which are common to the district and are met with over and over again by students.

Arthropoda (Crustacea only): The study of Arthropoda comprises only a consideration of crustacea and of *Limulus.* One afternoon is given over to study of tow which includes many crustaceans. The lobster and crab, including either the blue crab, *Callinectes,* or the rock crab, *Cancer,* are used for a complete dissection study.

A comparative study is made of crustacean appendages but this has been consider-

ably modified during recent years. It has been felt that it was unnecessary to stress too heavily the principles of homology and serial homology as these are usually well taught in every college in the land.

Accordingly this exercise was modified to form a comparative study of the external features of representative malacostraca. In this modified exercise the nature of the appendage and homology are taken into consideration and also such aspects as body form, body regions, presence or absence of carapace, nature of abdominal segments, etc. Points stressed in this study are also of definite diagnostic value. Thus they are features which, since they may be used as a basis of identification in the field, serve to coördinate in this respect the work of laboratory and field.

Study of Tow: This takes place in the laboratory although members of the class have the opportunity of observing methods of taking tow. Materials from Woods Hole passage and from the Fish Commission dock on both east and west tides have given consistently good material. That this serves as a good introduction to the study of plankton forms of the region is seen by the classified records of forms studied. To provide against the possibility of not having good, characteristic, living tow it has always been the practice to secure and preserve in formalin several batches on days previous to that of the exercise. It has rarely been necessary to use this preserved material.

Study of Lepas: An excellent method for this study has been worked out. The carina is carefully removed and, using a sharp sectioning razor, median sagittal sections of each animal are cut. Specimens prepared in this way make excellent material for the study of the structure of Lepas. Not infrequently the sections show the greater part of the nerve cord and in practically every case the arrangement and relations of the internal organs are obvious. Further dissection can also readily be made. In 1927 large *Lapas anatifera* were brought from the whistling buoy near the south shoal. Such individuals on account of the extra large size are rather more favorable for study, and exceptionally good sections are preserved for demonstration and study on succeeding years.

The activities of *Balanus eburneus* are studied regularly. Usually, shortly after placing adult specimens in finger bowls the metanauplius larbae are shed. Unless these are removed as soon as possible after shedding is completed the larvae are captured by the long raking movements of the thoracic appendages of the adult and devoured.

Living *Heteromysis* have been used in recent years for comparison with the "Mysis" stage of the lobster. (*Michtheimysis* is not found in July in the Woods Hole region although its larger size would make it a more satisfactory form for study.) In addition to living *Heteromysis,* preserved specimens, dehydrated by the usual method and cleared in synthetic oil of wintergreen (methyl salicylate) are available for study. Mysis stages of the lobster are somewhat infrequently obtained alive; preserved specimens are used when living ones are not available.

Limulus: Well advanced embryos of *Limulus* are secured during the last week in June. Several hundred are placed in a fingerbowl and exposed to sunlight and air. These usually develop so that they are at or near the hatching point some four or five weeks later and are used to illustrate the so-called "trilobite" larval stage of *Limulus.*

The Dissection of Limulus: An entirely new method of preparing *Limulus* for dissection has been worked out by Dr. E. C. Cole and has proved so satisfactory that it has entirely superseded the method formerly used in the course. By means of saw cuts the entire dorsal part of the carapace can be separated from the rest of the animal without difficulty and removed without injurying the softer parts of the animal. If the eyes are carefully cut around it is possible to trace the optic nerves to their endings in the eyes by this method. Animals may be prepared for dissection in a little over one minute using a small saw.

Mollusca: The trend which in recent years the work on the Mollusca has followed can be briefly stated. Lankester has said of the mollusca: "However diversified the external configuration of the molluscan body, the internal organization, at least in its main features and in young forms, preserves a remarkable uniformity." The group is homogeneous, sharply defined and its members are easily recognized. The mollusca also afford a very good instance of progressive modification and evolution of organic structure. It would be difficult to name a group of the animal kingdom in which relationships can be more clearly determined and the pedigree of the sub-groups more certainly traced; and for this reason no phylum in recent years has yielded such fruit-

ful results to the investigator. Under Dr. A. E. Severinghaus the molluscan work has gone on with a singleness of purpose; it has been a serious attempt to justify the above statements both through the lectures and the laboratory. To accomplish this end within five days it was imperative to make the lectures and the laboratory largely complementary. In the former it was the purpose to discuss as many of the important researches related to the molluscs as time permitted, especially those concerned with a better understanding of the coelom and the haemocoele, with their related organ systems. A discussion of the origin of these important body cavities opened up some of the most interesting literature in invertebrate morphology, and gave the opportunity of introducing to the students in a related way the lives and work of such men as Haeckel, Gegenbaur, Leuckart, Kowalevsky, Hatschek, the Hertwigs, Lankester, Sedgewick and others. It was necessary in such a discussion to emphasize the primitive condition of the circulatory, nephridial and reproductive systems, and this happily formed the basis for a clearer conception of modified molluscan structure as seen in the several classes. These modifications were left largely for the student to discover from his dissections in the laboratory. Each year there is in the class a group of students who have very little knowledge of molluscan anatomy. It is therefore necessary to furnish molluscan type forms for dissection. For this purpose *Chaetopleura*, *Busycon* and squid are used. In order to stress the progressive modification and evolution of organic structures emphasis was withdrawn from such interesting but specialized structures as the odontophore, radula and its muscles or the male reproductive apparatus of the squid and the student was urged to spend instead more time on the primitive Amphineuran structures and then proceed to the comparative study of such constant molluscan features as the mantle, food, gills, muscles and shell. By using this method it was hoped that the student would get, through his laboratory work, a thorough understanding of the primitive type of mollusc and some insight into the origin and development of structures discussed in the lectures. It is believed that there is little merit in acquiring by daily dissections an accumulation of knowledge concerning the varied structures of molluscan types or any other types for that matter if this knowledge is to be an end in itself. It is to be hoped that the student caught this attitude and that molluscs and members of other phyla will be remembered solely as illustrations in the fascinating story of invertebrate development.

Chordata: This work does not differ materially from that of previous years although in the last two years the study of living *Dolichoglossus* has been supplemented by the use of cross sections of proboscis, collar, gill and gonad regions serving to bring out the relations of the proboscis organs, of the gill mechanism and of the gonads. The slides formerly used for the study of the Bryozoa are kept over in aquaria and are again available for study of early stages of *Botryllus* and not infrequently *Ciona* and other ascidians. Such slides represent the development taking place in six weeks. As usual the last afternoon is spent in the independent study of *Botryllus* or *Amaroucium*.

(*To be concluded in the July 11th issue*)

1. **W. C. Allee**, The Invertebrate Course in the Marine Biological Laboratory. Biol. Bull. 41:99-131, 1922.
2. **J. A. Dawson**, The Cultivation of Large Free-living Amebae. Amer. Nat. 62:453-466, 1928.
3. **H. S. Jennings**, Behavior of the Starfish, Asterias forreri de Lorial Univ. Cal. Pub. Zool. 4, 1907.
4. **L. J. Cole**, Direction of Locomotion in the Starfish, Asterias forbesi. J. Exper. Zool. 14, 1913.
5. **A. E. Hopkins**, On the Physiology of the Central Nervous System in the Starfish, Asterias tenuispina. J. Exper. Zool. 14, 1926.
6. **G. H. Parker**, The Locomotion of the Sand-dollar, Echinarachnius. Anat. Rec. 31:332, 1925.
7. **V. L. Paine**, Adhesion of the Tube Feet in Starfish J. Exper. Zool. 46:361-366, 1926.
8. **J. E. Kindred**, The Cellular Elements in the Perivisceral Fluid of Echinoderms. Biol. Bull. 46:228-251, 1924.
9. **J. F. Gemmill**, The Locomotor Function of the Lantern in Echinus, with Observations on other Allied Activities. Proc. Roy. Soc. Lon. Ser. B. 85:84, 1912.
10. **C. Smith**, Approximate Schedule for Stages in Echinoderm Development, etc. Biol. Bull. 41:120-121, 1922.
11. **M. Copeland and H. L. Wieman**, The Chemical Sense and Feeding Behavior of Nereis virens Sars. Biol. Bull. 47: 231-238, 1924.

CHEMICAL ROOM

Dr. Oscar W. Richards

Instructor in Biology, Yale University

The Chemical Room supplies chemicals glass ware, clamps and support stands for use only at the Marine Biological Laboratory. Special Apparatus, batteries, gauges and reducing valves for gas cylinders are issued at the Apparatus Room (Brick Bldg. room 216). Supplies that are to be used by investigators elsewhere, such as microscope slides, cover glasses, shell vials, etc., may be obtained at the Supply Department (Frame Bldg. back of Brick Bldg.)

The following standardized solutions will be furnished in limited quantities during the season of 1931. Special solutions, buffers, glass

distilled water, and pH standards should be ordered at least two days before they are needed.

N 1.000 (with factor in the 4th place)

Acetic acid	Sulphuric acid
Hydrochloric acid	Sodium Hydroxide

N 0.100

Hydrochloric acid	Sodium hydroxide

Buffer mixtures

Acetate pH 3.6-5.6	Borate pH 7.6-10.0
Phosphate pH 5.4-8.0	

Acetate-citrate pH 2.2-8.0 (McIlvaine)

Indicators—Clark and Lubs series.

Color tube standards—on special order.

Glass distilled water—on special order.

For other standards inquire of the person in charge at the Chemical Room.

Attention is invited to the *Formulae and Methods* published by the Chemical Room in The Collecting Net (1930) for the composition of solutions and stain solubilities. Copies may be obtained at The Collecting Net office.

Certain common tools are available at the Chemical Room for temporary loan to investigators. In order that maximum use be made of these, it is requested that they be returned within 24 hours. When needed by other investigators they are subject to recall and will then be collected by the janitors.

Supplies no longer needed will be collected if word is left at the Chemical room.

Investigators are urged to co-operate with the Chemical Room by cleaning their glassware before returning it at the completion of their work. If the investigator will place his name on the Bulletin Board of the Chemical Room the janitors will return his supplies on the date indicated.

When the investigator is continuing the same work in the same room during the next season his supplies may be retained in the room if they are listed on a Kept Out card (furnished at the Chemical Room window) and the card left with the supplies. All supplies not so listed will be returned by the janitors. Should the investigator be unable to return the following summer the supplies will be returned to the Chemical Room stocks if they or the room is needed by other investigators.

Small amounts of special solutions will be kept during the winter for investigators in the Chemical Room on request. Supplies that may be injured by freezing should not be left in the wooden buildings.

MORPHOLOGY AND PHYSIOLOGY OF THE ALGAE

Dr. William Randolph Taylor

Director of the Course in Botany, Professor of Botany, University of Michigan

The plant group known as the Algae holds particular scientific interest in that it is a central one from which most, quite possibly all, other plant groups have been derived. At the same time it merges with the lines from which holozoic flagellates have come. Most algal groups by contrast have also established highly specialized evolutionary lines, contrasting in their advanced types with the generalized ones still extant. With this very great morphological diversity there is associated a wide range of physiological adaptation, and most extraordinary ecological association and distribution. As the algae are of ancient lineage there is a considerable paleobotanical history known in several groups, though for most there is, from the soft character of the organisms, no record. Their activity in laying down vast siliceous strata and as dominant influences in forming tropical reefs is continuing today. Economically their significance as the prime aquatic food source is obvious, and becoming increasingly exploited. Other more direct services, as for chemicals recovered by treatment, are also available, and slowly advancing in importance with us.

In America the number of persons sufficiently well informed respecting the algae, marine or freshwater, has never been high enough to accomplish even the pioneer cataloging of these plants over the country as a whole, let alone much monographic work of importance. Ten to five years ago the number of active investigators reached its low point, and there is now an increasing group developing and publishing in algal distribution, ecology and limnology. Some of these are former students in the Woods Hole course, and with the stimulus of association, competition and the training of more investigators, a much improved situation may be expected by the close of the next decade. Physiological studies involving algae have been rather limited in scope, principally due to the lack of information as to availability and individual characteristics of desirable types. Such intensive investigations as have used Spirogyra, Nitella, Valonia and Volvox will be matched with other algae and with different problems.

The course on algae at Woods Hole aims to give a general survey of the group first of all, for nowhere else in this country is it possible to do

so as effectively and with living material of fresh-water and marine types. There is but one other laboratory known to the writer which (under severe climatic limitations) attempts this task. This is an unescapable duty, for until someone lays the foundation there is no advanced training possible. In this general survey there is incorporated a study of the morphology and evolution of the groups based on a skeleton of the systematic classification. The striking physiological peculiarities of the various types are outlined, but no detailed general physiological exposition is practicable. This is due first to the fact that as yet we have only scattered observations, precluding generalization, and to the fact that the students have yet to secure that morphological background which would enable physiological discussions to be applied to the material. Enough of the fossil history of the groups is given to introduce the student to the topic. The ecological aspect is mainly approached in the field trips, which likewise introduce the student to the involved problem of recognition, collection and conservation of the living material. Since this country is yet in the pioneering stage where collection, identification and cataloging are desperately needed, the class is introduced to the technique and literature involved. During designated periods each week and at the end of the course opportunity and encouragement are offered for the initiation and prosecution of investigations in the various ramifications of this study.

BOOK REVIEW

Fundamentals of Health. (The Human Organism, Its Development and Conservation.) By T. Bruce Kirkpatrick and Alfred F. Huettner. 567 pp. (illustrated). Ginn & Co., $3.80.

In the homes of all intelligent people, there is frequent demand for a compact, well-expressed and clearly written statement concerning the human body and its functions. Not only does the younger generation need to have such reference material at its disposal, but most adults have at least occasional calls to refresh their minds and bring their own knowledge up to date. *Fundamentals of Health,* written as a college text-book of hygiene, serves this purpose in a most admirable manner. It is intended to give a "more substantial amount of scientific information concerning the origin, the development, and the functional characteristics of the human body, a basis for the formation of appropriate habits and attitudes concerning health."

In a direct and simple manner, T. Bruce Kirkpatrick, associate professor of physical education at Columbia University, and Alfred F. Huettner, associate professor of biology at New York University, review the basic principles of evolution and trace the development of the, individual through the embryonic stages of growth, which they correctly regard as an important period in the life span of the individual. A well-balanced discussion of genetics and human inheritance gives information concerning chromosomes, genes, sex linkage and inheritance, environment and heredity, inherited defects and susceptibility to disease.

In order to present intelligently the subject of foods and nutrition, the authors give a perliminary description of the chemical and physical properties of human protoplasm, the structure and functions of the alimentary system, the nutritive requirements of the body and the measurement of food values. An important section of this part of the book deals with the factors which determine food requirements and includes interesting height and weight tables for children and adults. The vitamins receive their due share of consideration, and their uses in prolonging a healthy life span are cited.

As "health is fundamentally the state of an organism which enables it most successfully to make appropriate adjustments to its environment," a consideration of the role of the muscles and their activity is necessary to appraise the importance of motor activity in relation to health. The heart and its circulation are also described from this same point of view; various disorders of the arteries and veins are discussed, together with an explanation of the effects on the heart of focal infections, drugs and tobacco.

Chapters on respiration and excretion are followed by an equally interesting section on nervous and emotional adjustments. The two succeeding chapters, dealing with the glands of internal secretion and with sex and reproduction, form one of the most important portions of the book. The directness and completeness of the treatment of these topics, grossly neglected in many books in hygiene, places *Fundamentals of Health* in the category of modern scientific literature which recognizes no need for undue reticence regarding these vital subjects. A consideration of immunity, immunization and public health problems brings the reader in contact with the social aspects of hygiene, and concludes this excellent treatise.

. . . .

(Signed) Arthur H. Compton
Edwin G. Conklin
Kirtley F. Mather
Harlan T. Stetson
Edward L. Thorndike

THE COLLECTING NET

A weekly publication devoted to the scientific work at Woods Hole.

WOODS HOLE, MASS.

Ware Cattell .... Editor

Assistant Editors

Margaret S. Griffin Mary Eleanor Brown

Annaleida S. Cattell

The Beach Question

Recently there has been much discussion concerning the curtailment of the bathing privileges at the Breakwater beach. A fence has been erected which runs down into the water excluding from use the finer and larger portion of the beach which has been for so long enjoyed by laboratory people and residents of Woods Hole. The post farthest from the shore extends well below mean high water. Many people claim that the land below the mean high water mark is public property and that formal permission must be obtained from the State of Massachusetts before placing any permanent structure below that point. We understand that this has not been done.

However, whether or not the action that has been taken is legal, it is not courteous. The owners of the property bordering the beach state that swarms of children in the day time and boisterous parties at night made conditions intolerable. Why could not the disagreeable features be eliminated without amputating a large portion of the beach solely for private use. We respectfully submit the following suggestion to the property owners north of the fence on the Breakwater beach:

We recommend that the courtesy of the northern portion of the beach be extended to adult members of the three scientific institutions between the hours of sunrise and sunset.

This arrangement would seem to eliminate all the objections that have been advanced by the property owners. Their scientific colleagues would be grateful for these privileges, and as guests, would respect every wish of their hosts.

A Book Service

This year the office of THE COLLECTING NET is prepared to obtain books for members of the scientific institutions at Woods Hole. We will confine ourselves primarily to books in the field of science, but we are ready to order any book which may be required during the summer. Soon we will have assembled in our library all the important books that have been published in the field of biology in the United States since last September which especially concern the Woods Hole group. Our library will be open all day and we hope that members of the laboratories will feel free to examine the books and use the comfortable couch and chairs.

Each time a book is sold a sum of money equal to the agent's discount will be turned over to THE COLLECTING NET Scholarship Fund. The magazine will pay every cost involved in the transaction. Long ago someone remarked that it would be desirable to use any profits that might result from publishing THE COLLECTING NET in the improvement of the journal rather than diverting it to the Fund: and then use the magazine as an agency to obtain the scholarship money in other ways. We have decided that this policy is the wisest one to adopt.

Directory Additions and Corrections

THE MARINE BIOLOGICAL LABORATORY

Anderson, R. S. res. assoc. Princeton.
Atlas, M. asst. emb. Columbia. Br 314. Dr 14.
Austin, Mary L. asst. prof. zool. Br 217B. Nickerson, Quissett.
Bakwin, H. asst. prof. pathol. New York. OM 38. Tinkham, Gardiner.
Bakwin, Ruth instr. New York. OM 38. Tinkham, Gardiner.
Ball, E. G. instr. phys. chem. Hopkins Med. Br 110. Veeder, West.
Butt, C. res. asst. Princeton. Br 116. Sylvia, Millfield.
Carabelli, A. A. med. stud. Pennsylvania. Br 114.
Castle, W. A. instr. biol. Brown. Br 233. Kittila, Bar Neck.
Dunbar, F. F. grad. asst. zool. Columbia. Br 333. Wallace (Falmouth).
Einarson, L. res. fel. Harvard Med. Br 108. A 107.
Eyre, Sara W. res. asst. Long Island. OM 45. D 209.
Favilli, G. asst. Inst. of Gen. Pathology, Royal (Florence, Italy) Br 208. Elliot, Center.
Graham, C. H. nat. res. fel. Pennsylvania. Br 231. Hilton, Main.
Green, Arda A. res. fel. phys. chem. Harvard Med. Br 108. Grinnell, West.
Hartline, H. K. fel. med. physics Pennsylvania. Br 231. McLeish, Millfield.
Johnson, H. H. Col. City of N. Y. Br 315. White, Millfield.
Loebel, R. O. Russell Sage fel. Cornell Med. Br 340. Nickerson, Church.
Margolin, S. grad. proto. Columbia. Br 314. Avery, Main.
Morris, Helen grad. Columbia. Bot. McInnis, Millfield.
Nelsen, O. E. instr. zool. Pennsylvania. OM 21. K 9.
Oltmann, Clara Columbia. OM 34. W h.
Reznikoff, P. instr. med. Cornell Med. Br 340. McKenzie, Pleasant.
Rugh, R. instr. zool. Hunter. Br 217M. D 303.
Schuett, J. F. zool. Chicago. Br 332. North.
Scott, Florence M. asst. prof. biol. Seton Hill. Br 217D. Nickerson, Millfield.
Sickles, Grace asst. bacteriol. N. Y. State Dept. Health. Br 122. Young, West.
Turner, J. P. instr. zool. Minnesota. Br 217N. Grinnell, West.

OCEANOGRAPHIC INSTITUTION

Bigelow, Elizabeth 109. Luscombe, Main.
Lambert, Anne 105. Young, West.
Redfield, A. C. prof. phys. Harvard. 103. Price, Church.

ITEMS OF INTEREST

Dr. and Mrs. John M. Fogg, Jr. sailed from New York City on Saturday, June 27, to spend the summer in Italy. Dr. Fogg has published recently in *Rhodora* on "The Flora of the Elizabeth Islands, Massachusetts." In pursuing his studies of these islands, Dr. Fogg spent a number of summers at Woods Hole, and for part of the time was collector for the Botany course. To those who are unacquainted with the story of the islands, Dr. Fogg's publication provides a very interesting description of their locations and early history which is well worth reading.

On Monday morning the statue of Confucius which ordinarily stands in the foyer of the laboratory was found in front of the bulletin board at the Mess Hall. During the night two young men had transported it in a wheelbarrow and left it with a bunch of daisies in its hands to greet those coming in to breakfast. After breakfast the statue was returned to its usual post.

Research workers, teachers, students and their friends are invited by Dr. and Mrs. Warbasse to the grounds of Gladheim, to walk the paths and to visit the gardens and the Point at all times. There are miles of winding foot paths about the grounds which offer views and vistas of the water and the foliage in fascinating variety and beauty. The sign at the entrance of the property, which proclaims, "Visitors Welcome," means precisely what it says.

In order that scientists visiting Woods Hole might have the advantages of prompt service and an opportunity to compare microscopes of different types, the firm of Carl Zeiss, Inc. has established an office and exhibition room at Woods Hole. It is located on Main Street opposite the Oceanographic Institution, and visitors are always welcome. Charles P. Titus, former president of the New York Microscopical Society and of the New Jersey Chemical Society is in charge. Mr. Titus conducted a School of Microscopy in New York for several years, where students received assistance in their special problems and difficulties. Facilities are also available for advice and help in the field of photomicrography, and during the summer it is expected that demonstrations of procedure will be made.

Mr. Victor M. E. Koch, vice-president of Carl Zeiss, Inc. will also be at the Zeiss office until the end of July. He and his wife and daughter, Miss Jimmie Koch, are staying at The Breakwater Hotel.

The Mount Desert Island Biological Laboratory

A number of research workers from the Laboratory went over to the Roscoe B. Jackson Memorial Laboratory, Wednesday evening, June 24th to attend the first of a series of seminars on cancer research. Miss Fekete was the speaker of the evening. She has been studying the histology of mammary glands in cancerous and non-cancerous strains of mice and gave a very interesting paper on the subject, which was followed by a lively discussion. After the seminar, Dr. C. C. Little took the members of this Laboratory on a personally conducted tour of the Jackson Memorial Laboratory.

The Laboratory will hold its annual Fourth of July picnic on Saturday afternoon at three o'clock on the shore in front of Dr. Lewis's cottage. Research workers and their families are cordially invited.

A limited amount of property called "The McCagg Tract" is owned by the Laboratory in Salisbury Cove. This land has been divided up into lots which are suitable for building and which are for sale to research workers on the condition that they will build a private dwelling thereon within a year. Within the last two years Dr. Esther F. Byrnes of Brooklyn, N. Y., Dr. Robert W. Hegner, Baltimore, Md., Dr. Margaret M. Hoskins, New York City, and Dr. Warren H. Lewis, Baltimore, Md., have purchased lots and built summer cottages. Dr. E. K. Marshall, Jr., Baltimore, Md., has just applied for Lot No. 6 which is adjacent to Dr. Lewis's property.

Dr. Duncan S. Johnson of Johns Hopkins University, and son, David, paid the Laboratory a brief visit last week. Dr. Johnson is spending the summer at Woods Hole as a member of the National Research Council.

Frances R. Snow, Laboratory Secretary

Dr. Albert Russell Mann, dean of the New York State Colleges of Agriculture and Home Economics at Cornell, has been elected provost of the university, an office newly created by the board of trustees. He has been at the head of the College of Agriculture for the last fifteen years.

Correction

The last two paragraphs at the end of Dr. Amberson's article on the physiology course belonged to the article by Dr. Goodrich on the embryology course. In paging our printer mixed the type and our proof reader failed to notice this unfortunate error. Dr. Amberson wishes emphasis placed upon the fact that a course in the embryology of the chick is not one of the entrance requirements for the physiology course!

The A. B. C. of Woods Hole for 1931

All Schedules Set to Daylight Saving Time — Bold Type Indicates P. M.

RELIGIOUS SERVICES

Church of the Messiah—Episcopal

Communion 8:00
Morning Prayer 11:00
Evening Prayer 7:30

Methodist Episcopal Church

Morning 10:30
Evening 7:30
Thursday Prayer Meeting 8:00

St. Joseph's Roman Catholic Church

Mass .... 8:00 and 10:00

Currents in the Hole

At the following hours (Daylight Savings Time) the current in the hole turns to run from Buzzards Bay to Vineyard Sound.

	A. M.	P. M.
July 6	9:45	10:10
July 7	10:32	11:03
July 8	11:20	11:55
July 9	....	12:06
July 10	12:44	12:57
July 11	1:31	1:40
July 12	2:24	2:31
July 13	3:07	3:19
July 14	3:58	4:08

In each case the current changes approximately six hours later and runs from the Sound to the Bay. It must be remembered that the schedule printed above is dependent upon the wind. Prolonged winds sometimes cause the turning of the current to occur a half an hour earlier or later than the times given above.

The average speed of the current in the hole at its maximum is five knots per hour.

Library Hours

Wednesdays and Saturdays

3:00 - 5:00
7:00 - 9:00

Telegraph Office Hours

Week-days 8:00 - **10:00**
Sundays 10:00 - **12:00**
5:00 - 7:00

Station Ticket Office Hours

Week-days 7:00 - **6:00**
closed from 10:30 - 11:30
Sundays **3:10 - 10:10**

Station Baggage Office Hours

Week-days 7:00 - **7:00**
Sundays Around train time only

Express Office Hours

Week-days only 8:00 - **5:30**

Post Office and Mail Hours

The Post Office opens at 7.00 and closes at 7.50.

Week-days

* Outgoing Mail closes

6:45 **12:25** **5:25**

Incoming Mail

6:50 10:30 **3:35** **6:09**

Sundays

Outgoing Mail closes

5:55 **6:25**

Incoming Mail 10:40

Laboratory Mail

Outgoing	Incoming
9:15	11:30
3:15	**4:15**

*Trains leave the station with mail a half hour after mails close at the Post Office.

BUS

Woods Hole — Falmouth

				Ex. Sunday							
Lv. Woods Hole	....	8:30	9:55	11:00	1:40	2:55	4:05	5:25	6:35	7:15	8:00	9:30
Due Falmouth	....	8:45	10:10	11:15	1:55	3:10	4:20	5:40	6:50	7:30	8:15	9:45
Lv. Falmouth	7:55	9:15	10:30	11:35	2:20	3:30	4:50	6:00	6:55	7:30	9:00	11:00
Due Woods Hole	8:10	9:30	10:45	11:50	2:35	3:45	5:05	6:15	7:05	7:45	9:15	11:15

Bus waits for Picture Shows and leaving times of **9:00 P. M.** and **11:00 P. M.** are approximate.

BOAT SCHEDULE

For New Bedford, Woods Hole, Oak Bluffs, Vineyard Haven and Nantucket

Leave	Daily	Daily	Daily	Daily	Daily	Daily
New Bedford	7:00	9:30	12:05	2:30	5:00	7:45
Woods Hole	8:20	10:50	1:20	3:50	6:20	9:05
Oak Bluffs	9:10	11:40	2:10	4:40	7:10	
Due Vineyard H.	....	....	....	....	....	9:55
Due Nantucket	11:30	2:00	4:30	7:00	9:30	

Leave	Daily	Daily	Daily	Daily	Daily ex. Sun.	Only Sun.	Daily
Nantucket	....	6:30	9:00	12:00	2:30	3:00	5:00
Vineyard H.	6:10	....	....	....	....	...	
Oak Bluffs	....	9:00	11:30	2:00	4:30	5:00	7:00
Woods Hole	6:55	9:50	12:20	2:50	5:20	5:50	7:50
Due New Bedford	8:20	11:30	2:00	4:30	7:00	7:30	9:30

TRAIN SCHEDULE

Woods Hole to Boston — Week-days

	Mon. only					
Woods Hole	7:05	7:15	10:10	12:55	3:20	5:55
Falmouth	7:12	7:22	10:17	1:02	3:27	6:02
Boston	9:05	9:10	12:30	3:00	5:40	8:00

Sundays Only

Woods Hole	6:25	8:20	Boston	8:30
Falmouth	6:32	8:27	Falmouth	10:32
Boston	8:35	10:27	Woods Hole	10:40

Boston to Woods Hole — Week-days

			Sat. only			
Boston	7:35	8:30	1:06	1:25	4:03	4:47
Falmouth	10:20	10:32	3:08	3:27	6:02	6:47
Woods Hole	10:30	10:40	3:15	3:35	6:09	6:55

THE WOODS HOLE LOG

The Junior Laboratory and Children's School of Science opened its doors to beginning investigators Monday, June 29th. All children over seven years of age are eligible to begin or to continue their scientific training during the summer in the School House. Older boys and girls who have completed the work previously offered at the Children's School of Science or who wish to supplement their high school biology are registered as students in the Junior Laboratory.

This newest branch in summer laboratory work at Woods Hole has proved highly successful during its previous seasons and is now well started on what would seem to be an even more profitable summer. The enrollment is not yet complete. The school is in charge of Mr. George A. Hutchinson of the Fieldston School in New York. He is assisted by a teaching staff of four; Miss Katharine A. Clarke of the Friends' School in Baltimore, Miss Elizabeth Kinney of Barnard, Mrs. Alice Clarke Mullen of the University of Virginia and Mr. Clifford C. Kilian of the McBurney School in New York.

The school session is from 8:45 to 11:30 every day and the courses include Nature Study for the seven and eight year olds; Advanced Nature Study and courses on the Forest and the Animals of Woods Hole for those eight to ten; General Science and an advanced course on the Animals of Woods Hole for those ten to twelve; and for those twelve to fourteen and over, Biology, Advanced Zoology and Biological Technique. In the latter course the pupils prepare and make slides for microscopical work.

The school has no connection with the Marine Biological Laboratory. Its management is in charge of a Science Committee headed by Mrs. Compton. The Marine Biological Laboratory of the future, however, may very well rest in some of these beginning young investigators' hands.

The Disabled Ex-Service Men's Exchange Sale will be held on Saturday, July 11th on the grounds of the estate of Mrs. Geoffrey G. Whitney on Nobska Road.

The worst forest fire which Cape Cod has had in years raged near Hatchville last Fall. The fire area covered forty-five square miles and extended as far as Bourne. Five or six cottages were burned. All the fire departments of the region were present including even one truck from Plymouth. Woods Hole was represented by the Fire Department and the Coast Guard. For a week the territory was ablaze and the firemen worked continually in day and night shifts. Direction of the fire-fighting was controlled from a plane and dispatches were dropped to the fire marshal.

Since that time there have been nothing but small house fires for the Woods Hole department to handle.

The Woods Hole Department is a branch of the Falmouth system, which now has five stations: one each at West Falmouth, East Falmouth, North Falmouth, Falmouth and Woods Hole. The system now has ten pieces of apparatus counting the new ladder truck which was added to the apparatus at its headquarters June 27th. The region is controlled from a look-out tower in West Falmouth. The Woods Hole department has two permanent men and a force of volunteers.

Bishop Sherrill of the Episcopal diocese of Massachusetts will pay his first visit to the Church of the Messiah on Sunday, July 12th. The Bishop will perform confirmation and preach at a special service at four o'clock in the afternoon. The regular evening service will be omitted.

This is the first year that movies have been shown in Falmouth on Sundays.

The University Players Inc. opened their season Monday, June 29th, with Philip Barry's recent Broadway success, "Paris Bound." With sophisticated, fast-moving dialogue, Barry has assayed the solution of some of the problems of modern marriage against a smart society background. The staging was excellent, the directing on the whole satisfactory, although the play would have been more brilliant if the tempo throughout had been slightly faster. Barry's plays are "talky" and depend somewhat for their success on a speedy bombardment of the sparkling lines on the audience. Christine Ramsey's character study of Fanny Shippan pleased the more, not only because her impersonation was vivid and amusing but because the tempo of her speech and actions was faster than the other characters. The entire cast was highly satisfactory and displayed a rare talent for acting.

The Players have been busy making improvements at Old Silver Beach as well as rehearsing, and this year a brick terrace was built at the entrance by members of the company and the lobby is hung with new draperies. There was dancing between the acts in the tea room.

M. S. G.

THE COLLECTING NET

Vol. VI. No. 3 SATURDAY, JULY 11, 1931 Annual Subscription, $2.00
Single Copies, 25 Cts.

COMMENTS ON THE LECTURE OF PROFESSOR E. B. WILSON ON "THE CENTRAL BODIES"

Dr. C. E. McClung

Professor of Zoology, University of Pennsylvania

In an admirable discussion of recent studies of Huettner upon the cleavage of Drosophila, of Sturdivant upon Ascaris spermatogenesis, and of his own restudy of Chaetopterus and Cerebratulus eggs, Professor Wilson presented his matured views upon the nature and structure of the central bodies in these objects. The lecture was illustrated by a series of his own beautiful photomicrographs, some of which were from the original preparations of Mead and Coe. Only incidental reference was made to the central bodies of other objects, Professor Wilson's endeavor being to show the uniformity, constancy and genetic continuity of these bodies in the taxonomically varied forms studied. Because of the difficulties arising in Echinoderm eggs from the close association between the central bodies and astral radiations, Professor Wilson was careful to point out the pressence of central bodies in (Continued on Page 71)

M. B. L. Calendar

TUESDAY, JULY 14, 8:00 P. M.

Seminar. Dr. H. H. Plough, "Some Observations on Self Sterility in Styela."

Dr. R. Chambers: "Evidence of a Direct Action of the Nucleus on the Cytoplasm in Tissue Cultures."

Dr. A. F. Huettner, "Genetic Continuity of the Central Bodies."

FRIDAY, JULY 17, 8:00 P. M.

Lecture. Dr. Eliot R. Clark, Professor of Anatomy, University of Pennsylvania, "The Microscopic Study of Cells and Tissues in the Living Mammal."

THE HOPKINS MARINE STATION AT STANFORD UNIVERSITY

Dr. W. K. Fisher

Director of the Station

Marine stations were popular in the Stone Age. On the shores of Europe and America a multitude of ancient shell deposits or middens bear mute witness to the immemorial lure of clams, oysters, and crawling things of low degree. Because the sea has always been a reliable source of food, early man may have first become acutely ocean-conscious by reason of his stomach. We may imagine these ancient camps as a primitive economic-social gesture which probably provided an agreeable means for the exchange of gossip, whilst clams ,and perchance a head or two, were being cracked.

Since those rather informal beginnings man's contact with the sea has become as complex as civilization itself; and instead of the crumbling shell mounds mixed with flints and the charcoal dust we have blossomed into such sea-side activities as New York, Gloucester, Deauville and Woods Hole.

TABLE OF CONTENTS

THE HOPKINS MARINE STATION OF STANFORD UNIVERSITY AT PACIFIC GROVE ON THE SHORE OF MONTEREY BAY, 130 MILES SOUTH OF SAN FRANCISCO

The Woods Hole Marine Biological Laboratory is the largest in the world, as the Stazione Zoologica of Naples is probably the most famous. Woods Hole is a dream of Agassiz developed by the energy of Whitman and Lillie. The Stazione Zoologica is Anton Dohrn's—in the land of Virgil on the sunny shore of "Mare Nostrum." With impeccable biological method we have now traced an idea from the Paleolithic to 1891, when four men at Stanford got their heads together.

These conspirators were Timothy Hopkins David Starr Jordan, Oliver P. Jenkins and Charles H. Gilbert. Dohrn's laboratory at Naples had greatly impressed Mr. Hopkins while Dr. Jordan had played a part in Louis Agassiz's Penikese experiment—the idea ultimately responsible for the great laboratory now at Woods Hole. The combination of these four men was a peculiarly happy one—all young, enthusiastic, each playing an essential part. So the idea started and so it happens that the Hopkins Marine Station is linked with two distinct biological enterprises on far separated shores. After forty years it is significant perhaps that the Hopkins Marine Station more nearly resembles the Naples Station than it does any of its other predecessors —but with features essential to its organization as part of a university. One of its buildings bears the name of Agassiz's son, Alexander, the great oceanographer. It is to be hoped that those responsible for leading the younger generation will remain mindful of the Penikese idea, which has been so ably interpreted in years past by Dr. Jordan and which gives biology its main value as a discipline in education. "Study nature not books," Agassiz insisted.

The first Station, known as the Hopkins Seaside Laboratory, consisting ultimately of two roomy wooden buildings, was planned by Jenkins and Gilbert and erected early in 1892 at Pacific Grove, on Monterey Bay, with money provided by Timothy Hopkins, on a small parcel of land donated by the Pacific Improvement Company—a syndicate which constructed the Southern Pacific Railroad and in which Stanford was then financially interested. The laboratory was only nominally a part of the University. It was supported by student fees and the deficits were patiently met by Mr. Hopkins.

Here gathered, during a six-weeks' summer session, men and women who investigated life as it is found in the ocean——which is an avowed purpose for which marine laboratories are established. Just that—life in the ocean; and the ocean which harbors the life. In addition, others crossed the continent and came from overseas, lured by the richness and accessibility of plants and animals. Animals were new and strange. Undergraduates were perforce investigators—a very fortunate circumstance since real education thrives in an atmosphere of research—be it ever so humble. So long as the ocean can provide problems which grip one firmly and demand to be solved, so long is the world safe for biological education!

The Seaside Laboratory was only one phase of Stanford's work in marine biology. Prior to the opening of the University Dr. Jordan, in collaboration with Dr. Gilbert, had spent considerable time studying marine fishes of the coast, and Dr. Gilbert had been an assistant naturalist on the famous U. S. Fisheries steamer, *Albatross*. After the establishment of the Hopkins Seaside Laboratory there were a number of extensive marine projects, among which may be noted: Expedition to Panama (Gilbert, Starks); to Mazattan (Jordan, Culver, Scofield, Williams); Fur seal investigation (Jordan, Adams, Greeley, Snodgrass); Hopkins Galapagos Expedition (Heller, Snodgrass); to Japan (Jordan, Snyder); *Albatross* Hawaiian Expedition (Gilbert, Snyder, Fisher); Samoan Expedition (Jordan, Kellogg); *Albatross* Alaskan Expedition (Jordan, Heath); *Albatross* Survey of California Coast (Gilbert, Heath, Fisher, Spaulding); *Albatross* Japanese Expedition (Gilbert, Heath, Snyder, Burke).

The present activity of the Hopkins Marine Station in the field of oceanic biology is therefore in line with what is essentially a Stanford *tradition*. The leaven was brought to the new University by the youthful and eager Jordan; perhaps it is a legacy from Louis Agassiz.

The new Station dates from 1916 and is due to the vision and energy of President Ray Lyman Wilbur who was himself a student at the old Seaside Laboratory. Another nearby site was chosen which by subsequent purchases was augmented to about eleven acres, comprising all of what was formerly known as China Point, from the presence of an old and picturesque Chinese fishing village wiped out by fire in 1903. This bit of China was dear to students of those days. One of its citizens, Ah Tak, was a skilled collector whose industry provided material for embryological monographs of importance.

The present name was adopted in 1917 when our first building was under construction. This unit, recently designated the Alexander Agassiz Laboratory, contains the general laboratories in which most of the undergraduate classes are held during the spring and summer, and houses members of the permanent staff occupied with the oceanological survey of the region and with the more established lines of research in biology.

In the summer of 1928 a second unit known as the Jacques Loeb Laboratory was completed from funds donated by the Rockefeller Foundation. This, like the Agassiz Laboratory, is of reinforced concrete. It consists of a central portion of two stories flanked by two wings of one story enclosing three sides of a front court, the over-all dimensions being ninety-five by one hundred and fifty-two feet. The building is intended for research in experimental biology, with more limited facilities for physical and chemical work. As a general principle, larger specialized laboratories are equipped rather than individual work rooms, although seven private rooms are available. Sea-water is conducted through pure lead pipes to a reservoir of 10,000 gallon capacity situated on an elevation of rocks whence it is fed by gravity to the aquarium tables. The principal laboratories and work rooms are equipped with hoods and are supplied with sea-water, hot and cold fresh water, distilled water, gas, pressure and suction air, and alternating and direct current.

Since 1918 the station has been open during the entire year. It now maintains a resident staff of seven specialists in addition to four assistants, a secretary, and a mechanician. This permanent staff is augmented during the summer by other members of the school of biological sciences of Stanford, and by a few visiting biologists. For instance, during the summer quarter there will be two additional members from Stanford, two from the Rockefeller Institute for Medical Research*, and one† from the Museum of Comparative Zoology.

Graduate students are welcomed during any of the four quarters, but undergraduate work is offered only during the spring and summer. We have come to view teaching as an incident of a yearly program! Climatically and otherwise, the best period for research is between October 15 and June 15.

If the Hopkins Marine Station were concerned solely with instruction of students in those phases of biology most advantageously undertaken at the seashore, its work would be simple and inexpensive. But it is quite otherwise, for no institution is content to use knowledge already acquired without adding a considerable quota of new material through original investigation.

Looking at the matter very broadly there are two attitudes of the biologist toward the ocean. He may use oceanic animals and plants simply as material for the investigation of general problems without reference to their "marineness", because in experimental work, for instance, there is great advantage in being able to control precisely the environment of an animal. Sea animals are intimately surrounded by water which can be minutely modified as to temperature and chemical composition in comparison with the normal sea-water in which the animal is found in nature. This is, roughly speaking, the attitude of the general biologist. He is interested in the ocean as a most valuable source of material for certain fundamental lines of research. By far the larger number of investigators who visit marine biological laboratories belong to this category whatever prefix they may fasten to their "logy."

*Lawrence R. Blinks, Leonor Michaelis
†Elisabeth Deichmann

A rapidly increasing number, however, are interested in that extraordinary complex known as the ocean, of which water is merely the obvious, visible part. These people approach the ocean as an environment of life and consider its living contents with due reference to the multifarious aspects of this environment. Oceanologists run the gamut from mathematicians concerned with hydrodynamics—through physicists and chemists interested in the behavior of an extraordinarily variable solution of earth—to biochemists and biophysicists working with the operation of physical laws upon aquatic life; to physiologists occupied with the responses of animals occasioned by the environment; to a multitude of specialists in zoology and botany who must work out the innumerable technical aspects of their subject with reference to development, life habits, and application to the needs of mankind. Just here is where marine biology and commerce meet. The resources of the sea are usually exploited with a porcine greediness that takes for granted an unending supply. When ruin is in sight the Exploitation seeks a miracle from Science to save it from its own folly. Too often the long suffering biologist, called in like a physician when the patient is dying, can do little more than give advice, which often goes unheeded in the absence of drastic laws.

An enumeration of projects under way at the Hopkins Marine Station would suggest the scattered blocks of a mosaic rather than an easily discerned picture. This is occasioned by the magnitude of the material and the scarcity of funds and investigators.

Under the general supervision of Dr. Tage Skogsberg in cooperation with the California State Fish and Game Commission, an oceanological study of Monterey Bay is being prosecuted. This work involves frequent trips aboard the State Fisheries patrol boats, *Steelhead* and *Albatross*, for the painstaking collection of data of various sorts. Water samples from different stations are being analyzed for temperature and chemical changes in order to understand the movements of water and for correlation with the migrations of open sea fishes, especially of the sardine and mackerel.

THE RESIDENT STAFF OF THE HOPKINS MARINE STATION

From left to right they are: Harold Mestre, B. E. MacGinitie, W. K. Fisher, the Director, C. B. van Niel, Tage Skogsberg and Harold Heath.

By means of tow-nets hosts of minute floating organisms, the ultimate food supply of oceanic animals from sardines to whales, are being taken at various depths. Several graduate students are working on different groups of these "plankton" organisms, as they are called, since they are as economically important as they are intrinsically interesting. Their absence creates an ocean desert, and there are plenty such. From the unlighted mid-region between the surface and bottom many bizarre and unusual forms continue to thrill the dyed-in-the-wool zoologist. Dr. Heath has recently exhaustively studied a small, transparent worm-like creature, a link between two major groups heretofore believed safely separated.

It has been amply demonstrated that the methods of science yield good returns when applied to problems of economic importance as to those removed from the concerns of life. Eugene C. Scofield of the State Fish and Game Commission is a liaison member of our oceanological project, working now in the field on the sardine problem, and he has recently covered not less than 8,000 miles of cruising off the California coast. Joseph H. Wales is investigating the rock cods, a fishery greatly depleted; and W. A. Dill, the group of fishes which contains the flounders and halibuts. Rolf L. Bolin is investigating the open sea floating eggs and larvae of various fishes. Dr. D. S. Cope is in charge of the chemical side of the Survey.

Nor is the bottom being neglected, for, besides yielding fascinating material for students and the zoologists of the staff, its deposits are keeping E. Wayne Galliher busy. As a matter of fact the material of the bottom differs greatly in content and weight from place to place, with varying mixtures of organic material, both living and dead. It is the seat of physical and chemical changes and is preparing to become the solid rock of some future land, in its turn to be resolved into soil again and washed back to sea.

When one visits the seashore, he has little opportunity to see, much less study, the complex life of the open water. But the crowded assemblage of plants and animals which make their homes between high and low tide is accessible to anyone. The very fact that they are able to survive long exposure to air, even to partial dessication, sets them apart as different from creatures which are always submerged. If life originated in the ocean, as many biologists are convinced it did, then it is obvious that the ancestors of all land animals and plants must at one time or another have accustomed themselves to life outside of water. But most of the intertidal animals have simply been immigrants from shallow water forced through competition to take a desperate chance in a very unfavorable environment. The result has been thousands of new forms, new communities, new responses—a distinct world of life obviously neither terrestrial nor yet entirely marine.

The extraordinary rich fauna and flora of the Monterey Bay region offer exceptional opportunities to the investigator and beginning student alike. There is a surprisingly large number of marine animals and plants readily accessible. Such include not only the species found between tide levels, but also those which dwell in the open ocean, and those which are secured by dredging at various depths. The student of land forms will find an equally interesting and in some ways peculiar assemblage of material. This is in part due to an unusual variety of physiographic and climatic conditions within a relatively small area, and in part to the presence of a number of characteristic and dominant types such as the Monterey Cypress and Monterey Pine. The particular advantage of work at the Station is the possibility of observing and studying a large number of living animals while these are still fulfilling their role in the general scheme of marine and terrestrial life. Investigators in the fields of general experimental work, taxonomy, anatomy, and embryology, will find a wealth of material to choose from, while those concerned with a study of animals from the special standpoint of their "marineness" will naturally be exceptionally favored.

The wealth of marine forms is in part due to the diversity of environment, which ranges from a rugged granite coast, broken by beaches, to sheltered estuaries alive with mud-loving species.

The groups which especially give character to the fauna are the coelenterates, polyclads, nemerteans, bryozoans, echinoderms, chitons, gastropods, polychaets, the higher crustacea, and the tunicates. Among actinians, Evactis, Epiactis, Urticina, and Corynactis are the high lights. The solitary coral, Balanophyllia, is abundant. There are about ninety species of hydroids, and Scyphozoa are represented by Aurelia, Chrysaora, and Pelagia. Siphonophores and ctenophores are occasionally common but of uncertain occurrence.

For experimental biology an abundance of sea urchins (*Strongylocentrotus purpuratus* and *franciscanus*) is available. The sea star, *Patiria miniata*, is equally good. *Leptasterias aequalis* and *Henricia leviuscula* brood their eggs. The same is true of the small holothurians, *Cucumaria curata* and *Thyonepsolus nutriens*.

There are upward of fifty species of chitons, the largest, *Cryptochiton stelleri*, reaching a length of twelve or fifteen inches. Urosobranch and nudibranch gastropods abound. The large abalone (*Haliotis*) is the outstanding mollusc of the coast. Dorid nudibranchs are conspicuous for their size and brilliant coloring. The bay teems with squid

in spring and summer, and octopus, which is common but not easy to procure, reaches a weight of forty pounds.

Among the polychaets are numerous representatives of Halosydna, Polynot, Nereis, Leodice, Lumbrinereis, Glycera and Amphitrite. A showy sabellid Eudistylia, is abundant, while every rock pool is alive with serpulids. *Arenicola* is less easily procured. A big echiuroid, *Urechis caupo,* is an almost perfect type for experimentation, and its large clear eggs can be procured without injury to the animal. Sipunculids are abundant and large. Conditions appear to be ideal for flatworms and nemerteans. Bryozoa, especially the encrusting forms, are conspicuous and complete for available surface with sponges and very thrifty compound ascidians.

Among the crustacea the crabs are most conspicuous, but of more interest are the primitive burrowing shrimps, Callianassa and Upogebia. Emerita is abundant as are also pagurids and several mysids. Barnacles of several species are very abundant on the granite and, of course, swarms of isopods and amphipods.

Mention should be made of the hag-fish, Polistotrema, of the chimaeroid, *Chimaera colliei,* and of the midshipman, *Porichthys notatus,* which is equally interesting for its conveniently deposited eggs and numerous photogenic organs.

The plankton of the bay is rich in larval forms and protozoa.

Bringing students in contact with this world is a major concern of the Station, as is a more formal study of the interrelationships of the plants, animals, and physical environment undertaken by Prof. George E. MacGinitie. No better introduction to biology has been found than scientific natural history (ecology). Yet no one man is equipped to cover the whole field in its technical aspects. There is work here for everyone. The extreme richness of shore life in the Monterey region as well as the great diversity in the shore itself are among the principal assets of the Station.

Dr. Harold Mestre is attacking the complex problem of photosynthesis from the photochemical standpoint. Abundant marine algae, some growing in thin sheets like sea lettuce (Ulva), and some of the minute single-celled forms, furnish ideal material for this work.

Light does not pass through water as it does through air, but is rapidly absorbed. The red rays can penetrate only a few fathoms, while the blue and violet go farthest—to about one-fourth of a mile in very clear water with the sun directly over head to avoid loss by reflection. This penetration of light is being studied by Dr. Mestre with a submarine spectrograph in order to determine the effects of the energy supply on the abundance of sea life.

Still another interesting problem is that of the effect of ultra-violet light upon the organism itself. For instance, it has already been found that the unfertilized eggs of a marine worm *Urechis caupo,* can be made to develop and grow for several days when irradiated. This fact offers a new approach to the old question of parthenogenesis made so famous by the work of Jacques Loeb which was done on this very spot.

Investigations into the nature of photosynthesis have been confined to this process in green plants, because until recently it had not been elsewhere recognized. But a group of bacteria, known as purple bacteria, can build up living matter out of inorganic constituents under the influence of light. This type of photosynthesis has been intensively studied by Dr. C. B. van Niel. It is of especial interest in this connection that the "purples" have probably acquired their photosynthetic power independently of the green plants and that they do it differently. Ordinary plants use carbon dioxide and water in the presence of light; the "purples" substitute hydrogen sulphide for water—a very remarkable difference.

The ultimate aim of studies on photosynthesis is to understand the mechanism of the process to the end that we may be enabled to carry out this reaction without the aid of living plants. Our concepts of this mechanism have already undergone some changes as a result of the investigation of bacterial photosynthesis, and the time does not seem too far off, in Dr. van Niel's opinion, when we will be able in the laboratory to reproduce the conditions under which it occurs in plants.

Since 1919 the California State Fish and Game Commission has made the Agassiz Laboratory its headquarters for the study of the sardine. This work is quite independent of its cooperation in the Oceanological Survey.

Some long-continued work by Dr. Heath on the embryonic development of marine organisms and by Dr. Fisher on the classification and anatomy of marine animals has more technical than popular appeal. For over thirty years Dr. F. M. McFarland has studied the delicate nudibranch molluscs of the coast and Mrs. McFarland has painted their portraits. Space is not available to catalog the research done by biologists of other institutions who have availed themselves of the Station's facilities. They include, among others, such old friends as J. H. Ashworth, H. B. Bigelow, Calvin Bridges, W. R. Coe, E. G. Conklin, B. M. Davis, P. S. Galtsoff, Torsten Gislén, Bertil Hanstrom, Libbie Hyman, J. S. Kingsley, Harold Kylin, F. R. Lillie, Albert Mann, Otto L. Mohr, A. R. Moore, T. H. Morgan, Joseph Needham, H. H. Newman, A. C. Redfield, A. H. Sturtevant, David Tennent.

The permanent staff consists of W. K. Fisher, Professor of Zoology; Harold Heath, Professor of Embryology; George E. MacGinitie, Assistant Professor of Zoology; Harold Mestre, Assistant Professor of Biophysics; Tage Skogsberg, Associate Professor of Marine Biology and Oceanography; C. V. Taylor, Herstein Professor of Biology; C. B. van Niel, Associate Professor of Microbiology; Tadaichi Hashimoto and Danella Straup Cope, Research Chemists.

COMMENTS ON THE LECTURE OF PROFESSOR E. B. WILSON

(Continued from Page 65)

Ascaris and Drosophila when astral rays are lacking. The various stages in the movement of the large and clearly defined centrosomes about the nucleus, until they reach opposite poles, were clearly shown in Ascaris spermatocytes. The presence of hundreds of mitoses, all in about the same stage, in the egg of Drosophila affords an excellent opportunity to study the mitotic figure. Here Professor Wilson was able to demonstrate the successive stages in the division and movements of the centrosome and its derivatives, and to show the variations which appear in the process The preparations of Drosophila were made by Dr. Huettner and will serve him as the basis of a report to be given later this summer.

Professor Wilson pointed out in the beginning that there is nothing new in the major features of centrosome phenomena reported and that these were beautifully worked out by the early masters of cytology—Boveri, van Beneden, Flemming and others. Because of the minute size of the central bodies and the difficulty of observing them, there have always been doubts as to their reality, and these persist to the present day. It was Professor Wilson's desire to remove any uncertainty in his own mind that led him to take up once more a subject which has been of great interest to him from the time when he contributed to the overthrow of Fol's theory of the "quadrille of the centers." No one is better qualified by experience and ability to discuss this subject, and Professor Wilson presented a demonstration of unquestionable clearness that in the forms studied the central bodies are realities, with a well defined and constant cycle of mitotic changes. So far as conditions in the spermatocyte of Ascaris are concerned, I can confirm them by observations upon Orthopteran cells. Except for relative sizes there is practically no difference in the two widely removed species. One familiar with such material can have no doubt of the reality and constancy of the central bodies in the male germ cells of animals. If, however, there are still those who doubt the existence of such relatively large bodies as the chromosomes, despite their demonstration in the living condition by various means, it will doubtless be long before there is agreement regarding the nature of the minute central bodies. Their demonstration in the living condition would do something to lessen uncertainty regarding them and it is to be hoped that Professor Wilson may be able to add this bit of evidence to the large mass which he has already accumulated.

THE ARCHITECTURE OF THE HEPATIC CELLS OF AMPHIUMA

Dr. Arthur W. Pollister

Instructor in Zoology, Columbia University

The tissues of Amphiuma are exceptionally fine material for cytological studies; first, because this animal has the largest cells of any Vertebrate; and second, because, like most Amphibia, it seems to be especially suitable for successful application of technical methods for study of the tissues.

In the present study the material was prepared by standard technical methods for the general histological picture, by the special methods of Benda and Kull for demonstration of mitochondria, and by the Kolatchef process for blackening the Golgi apparatus with osmic acid.

The liver of Amphiuma has large, irregularly polyhedral glandular cells, the relationship of which to one another is much like that of the cells of the mammalian liver. Most of the bile canaliculi are tubes formed by the apposition of parallel grooves in the surfaces of two contiguous cells. The ducts are all of practically the same diameter. They anastomose extensively to form a complex network, from which project many short side branches that end blindly. The canaliculi may occur on any part of the cell, except that they are never on a surface that is adjacent to a blood capillary. At places the network of canaliculi is continuous with the smaller ducts of the liver and through this duct system the secretory product ultimately reaches the hepatic duct. In addition to these intercellular canaliculi bounded by two hepatic cells, there are ducts that are intracellular, actually penetrating the cytoplasm of the liver cell. These are of the same inside diameter as the intercellular canaliculi and are always connected with them. The most frequent condition is for the intracellular duct to extend through the cell and open into the intercellular canaliculi at opposite sides of the cell. Not infrequently this intracellular tube has a short side branch, and exceptionally a rather extensively branched system is seen. That the duct is actually intracellular,

and not merely an intercellular duct seen at the upper surface of a cell, is evident from the occurrence of sections of cells in which the nucleus is seen at the same level as the intracellular duct, since the nucleus is never at the surface of the hepatic cell.

A study of the details of structure shows that the two types of canaliculi are somewhat different. The material prepared by the Benda method is most useful for this study, although it can also be made out in material fixed in Helly's fluid and stained with iron hematoxylin, or in that prepared by the Kull process. In Benda material the cell boundary shows a double layer, an outer very thin line that stains heavily with the crystal violet and an inner thicker zone stained with the alizarin. The walls of the intercellular ducts are composed of both these layers, as would be expected from the fact that they are morphologically only spaces between two cells. The intracellular ducts, however, have walls composed of the purple-staining membrane only. Another feature characteristic of the intracellular ducts is the presence, a short distance outside the margin of the wall, of a row of small granules that stain faintly with the crystal violet. These must certainly surround the entire circumference of the duct, but I have not been able to see them when focussing above or below it, probably because they are so small and so faintly stained.

This duct system is peculiar to liver cells. In most glands there are tubules or acini in which several cells surround the lumen into which the secretion is passed, and in such a case only the tip of each cell is in contact with the lumen. In these cells we find the Golgi apparatus always lying adjacent to the lumen, in the region where the secretion is being formed, a relationship that has been held to be circumstantial evidence that this cell component is in some way concerned with the synthesis of the secretory product. This topographical relationship is very much more striking in the liver cells of Amphiuma. Here the region where the visible evidence of the synthesis of the secretory product first appears is not merely at one point in the cell, but is a zone adjacent to the bile canaliculi. The Golgi apparatus in these liver cells always lies along these complex secretory zones, and is never found in any other part of the cell. It seems to be an irregular network a short distance inward from the surface grooves and surrounding the intracellular canaliculi.

Another constant feature of the structure of these hepatic cells of Amphiuma is the presence of one or more clusters of fat droplets. These are gray after treatment with two per cent osmic acid in the Kolatchef method. The blackening is removed by the standard treatment with rectified turpentine, which leaves the intense black of the Golgi apparatus unaffected. The fat droplets have a very definite orientation in the cell. They are apparently never found at any place except that part of the cell adjacent to a blood capillary. This relationship of the fat droplets to the capillaries is especially emphasized by the fact that all the cells adjacent to a capillary show fat droplets in the part near it. Only a small percentage of the cells are found with a cluster of fat droplets and no capillary visible in the immediate vicinity, and these are easily explained by the vagaries of sectioning.

The mitochondria of the hepatic cells of Amphiuma, when properly fixed, are all of the filamentous type generally characteristic of vertebrate glandular tissues. The filaments are all of the same diameter, but there are a long and a short type that are clearly distinct in their distribution. In the general cytoplasm, away from the nucleus, adjacent to the blood capillaries and to contiguous liver cells, there are very long chondrioconts that are relatively few in number. In the zone around the nucleus and frequently in another region around the intracellular canaliculi are dense clusters of very much shorter mitochondria. Those in the vicinity of the intercellular ducts are also mostly of the short type, but they are not concentrated as in the other two localities.

Some of those who have worked on the Golgi apparatus of liver cells have found it to be located as I have just described in Amphiuma, while others have found it to be a juxta-nuclear mass, as it is so frequently in other gland cells. It appears to me possible that the following may explain this discrepancy. It is well known that the mitochondria are often blackened by methods used for the demonstration of the Golgi apparatus. Indeed, in Amphiuma, in which the Golgi apparatus reaction to osmic acid is the most positive I have ever seen, cells are occasionally found in which the mitochondria also are blackened. If it happened that this reaction occurred very strongly in the dense juxta-nuclear zone of chondriosomes, rather than in what I have described as the real Golgi substance along the bile canaliculi, the result would be a demonstration of a blackened mass which could be easily interpreted as a Golgi apparatus adjacent to the nucleus.

I wish to point out also what may possibly be a wider significance of studies on liver cells. Some workers on gland cell structure have come to the conclusion that the typical pictures of the Golgi apparatus are due to the impregnation of mitochondria in the so-called secretogenous zone of the cell, and they have produced as evidence examples of perfect impregnation of mitochondria in this region. Now in such cells the secretogenous zone, between the nucleus and the lumen, really has two topographical relationships. It is a region where secretory products first become visible, and it is also a region close to the nucleus. In the hepatic cells of Amphiuma these two regions are obviously quite separate and it seems clear that the juxta-nuclear region is

characterized especially by the presence of a dense mass of mitochondria, while the secretogenous zone is primarily the location of the Golgi apparatus. It seems to me possible that this point of view may offer an approach to resolving the confusion that exists today with regard to the true structure of the secretogenous zone of typical glandular epithelial cells.

REVIEW OF THE SEMINAR REPORT OF DR. POLLISTER

DR. H. W. BEAMS
Assistant Professor of Zoology, University of Iowa

Dr. Pollister's interesting paper on the architecture of the hepatic cells of Amphiuma sheds considerable light upon the long existing controversy as to whether or not there really exists in the hepatic cells a definite system of intracellular bile canaliculi. It was long ago suggested by students of the liver cell that a system of intracellular bile canaliculi could be demonstrated by the application of the impregnation methods of silver nitrate, and the administration through the hepatic duct of a variety of injection fluids. However, the conception of intracellular bile canaliculi has not been widely accepted and recent histologists have seriously questioned this interpretation. Maximow ('30), for instance, states that the view of intracellular bile canaliculi is incorrect and what has been described as intracellular canals is probably part of the Golgi network. Others have suggested that the so-called intracellular bile capillaries demonstrated by the injection methods are simply artifacts, in the sense that the cell has been ruptured by the pressure developed in the process of administering the injection fluid. While still other histologists seem to interpret the intracellular bile canaliculi as temporary phases of functional activity, accompanying the discharge of secretion.

The findings of Dr. Pollister in the hepatic cells of Amphiuma demonstrate clearly, and beyond doubt, the presence of a permanent system of intracellular bile canaliculi. His observations are indeed important. They should go a long way to help clear up the present controversy concerning the presence of intracellular bile canaliculi, at least to the extent that they do exist in certain types of liver cells. Just how general this condition may be found to exist in the hepatic cells of other animals remains to be proved.

It was of particular interest to the reviewer to note that Dr. Pollister did not observe a network of fine intracellular blood capillaries in the liver cells of Amphiuma, as described by Schafer for the liver cells of the rabbit. There has always been much skepticism expressed as regards the interpretation of Schafer; notwithstanding the apparent ease with which he and his students have been able to inject these capillaries, even to the extent of demonstrating them within the nucleus. Inasmuch as the liver cell of Amphiuma has proved such excellent material for the demonstration of the intracellular bile canaliculi it might likewise be assumed to prove favorable material upon which to repeat the methods, and test the theory of Schafer. It would also be of particular interest to some to know just what relationship, if any, the intracellular bile canaliculi bear to the "trophospongium" (nutritive canals) of Holmgren.

The distribution of the Golgi apparatus in the hepatic cells of Amphiuma, in juxtaposition to the intercellular and intracellular bile canaliculi, which marks the secretogenous zone for bile at least, is of great interest in view of the current conceptions of secretion. The striking topographical relationship of the Golgi apparatus to the intercellular and intracellular bile canaliculi seems to offer strong support to the current theory that the Golgi apparatus plays an important role in secretion. However, since the liver cells perform so many diverse functions, and since any one of the cells is presumably capable of performing all of the functions, it becomes difficult to correlate the presumed formation of the synthetic products of the liver, on the basis of the Golgi apparatus theory of secretion. If the Golgi apparatus constitutes the secretory route of the cell, one should expect to find some such arrangement as that described in the thyroid gland by Cowdry where the Golgi apparatus shows a reversal in polarity. Unless some cytological explanation is given to account for the presumed endocrine-like function of the liver, it seems that we are not justified, for the present at least, in concluding that the Golgi apparatus is the single synthetic center of the cell. Furthermore, it is of interest to note that the Golgi apparatus in the salivary glands of the Chironomus larva show apparently no relationship to the intracellular, secretory ducts (Krjukowa). It would seem therefore, as Dr. Pollister has clearly pointed out, that the relationship of the Golgi apparatus to the formation of secretion (bile) in the liver is at present circumstantial. However, it is very probable that the relationship of the Golgi apparatus to the intercellular and intracellular bile canaliculi actually signifies a definite physiological association rather than a chance position. But just how general this condition may be found in other secreting cells remains to be proved.

The observations of Dr. Pollister on the mitochondria in the liver cells show quite clearly that they are discrete structures and do not become hypertrophied to form the Golgi apparatus as claimed by Parat. As a matter of fact the mitochondria in the "zone of Golgi" are composed mostly of short rods, a condition quite different from the "active" chondriosomes of Parat.

An interesting phase of the study of the Golgi apparatus upon which Dr. Pollister did not report, and which might profitably be investigated in the liver cells, especially in view of the recent findings of Dornesco, is whether or not the Golgi apparatus is the same as the neutral-red-staining vacuome of Parat. Also, if not identical, what is the topographical relationship which exists between the Golgi apparatus and the neutral red bodies of Makarov and of Ludford, who assume that the neutral red bodies are formed by the influence of the Golgi apparatus.

EFFECTS OF HYDROGEN ION CONCENTRATION AND SALT CONCENTRATION ON THE OXYGEN DISSOCIATION CONSTANT OF HEMOCYANIN

Dr. Alfred C. Redfield
Professor of Physiology, Harvard University

One of the incentives for the study of hemocyanins has been the hope that in this group of pigments conditions would be found which are sufficiently at variance with those characterizing hemoglobin and also sufficiently simple, to enable further light to be thrown on the mechanism by which oxygen is transported in the blood.

In the case of three hemocyanins, that of Helix, Busycon and Limulus, a system is obtained when the pigments are purified which has a rather simple behavior in its relation to oxygen. The equilibrium proceeds as though the hemocyanin unites with one atom of oxygen to form oxy-hemocyanin in accordance with the mass law. One may consequently deal with the factors influencing the oxygen equilibrium in a very definite way, because one can state their effect in terms of the oxygen dissociation constant.

The change in the oxygen dissociation constant of Busycon hemocyanin with varying hydrogen ion concentration may be explained on the assumption that the neutralization of certain acid or base binding groups produces a hemocyanin salt with an oxygen dissociation constant different from that characterizing the acidic (or basic) form of the hemocyanin. The relation between hydrogen ion concentration and the value of the oxygen dissociation constant may be described by the equation developed by Ferry and Green in connection with an analagous treatment of the problem in the case of hemoglobin. The presence of NaCl at 0.5 molar concentration does not influence the form of the oxygen dissociation curve and has little or no effect upon the value of the oxygen dissociation constant of the hemocyanin or its salt, but changes by about one and a half pH units the reaction at which occurs the formation of the supposed hemocyanin salt.

REVIEW OF THE SEMINAR REPORT OF DR. REDFIELD

Dr. F. G. Hall
Professor of Zoology, Duke University

It has been said that hemoglobin is the most interesting substance in the world. Hemocyanin now shares some of that interest. Dr. Redfield, more than anyone else, has contributed to our knowledge of the function of hemocyanin in marine organisms. He has shown that the same general physico-chemical principles which apply to the function of hemoglobin are likewise applicable to the function of hemocyanin.

There are several points that come to one's mind in comparing the function of hemocyanin with hemoglobin. Does hemocyanin behave quantitatively in the same manner when isolated from the blood and purified as it does in its natural environment? It is well known that the dissociation of oxygen from purified hemoglobin is quite unlike that of hemoglobin within the intact corpuscle in whole blood. Since hemocyanin is carried in the plasma one would not expect such a great difference as in the case of hemoglobin. Dr. Redfield's data indicate such a condition to obtain, and it is very likely that his studies give us a true picture of the function of hemocyanin in nature.

To one interested in marine problems a comparison of the function of hemocyanin and hemoglobin is of interest because each makes use of a metal, copper and iron respectively, which are relatively very rare elements in sea water. In most analyses they are only reported as traces. Yet in the blood of Molluscs, Arthropods, and Vertebrates one or the other of these two metals are the essential element of the respiratory pigment and organisms seem well supplied with them. A study of the copper and iron cycle in sea water would perhaps be worth while.

The problem of the influence of temperature on the function of hemocyanin, alluded to by Dr. Redfield, is still an open one. It is in about the same state of solution as in the case of hemoglobin. We do not yet know the mechanism by which oxygen is unloaded from either hemocyanin or hemoglobin at the low temperature at which many marine animals live. Dr. Redfield has shown in a previous study that squid, for example, are dependent upon hemocyanin for their oxygen supply. They cannot maintain themselves on the oxygen physically dissolved in the blood plasma. Thus in animals living in an environment low in temperature it would appear that the respiratory pigment has some special way of giving up its oxygen to the tissues. The fact that salts have very little effect on the oxygen dissociation of hemocyanin is advantageous to animals that live in the sea.

Finally, one is led to conclude that Dr. Redfield has made significant contributions to both general and comparative physiology.

THE COURSE IN INVERTEBRATE ZOOLOGY AT THE MARINE BIOLOGICAL LABORATORY*

Dr. James A. Dawson
Assistant Professor of Zoology, College of the City of New York
Director of the Course

Field Work: This has always been emphasized in this course and, it is felt, rightly so. In the field the student sees the animal in its normal surroundings and the greatest freedom is given for the study of any phase of the activities of marine littoral animals. The organization of the field work has so far as the equipment, method of division of the class under instructors and localities visited, been continued largely as described in Allee's account. In 1926 Crane's wharf was removed and field trips to Nobska or Quissett have been substituted.

As an illustration of the schedule of field trips that of 1928 is given. Those of the other years are essentially similar, the only differences being the different dates and occasionally somewhat different localities, both occasioned by local conditions of tide or weather.

Field Trip Schedule for 1928

June 30, Saturday — Protozoa Collecting Trip—Fresh, Brackish and Salt Water. Start 9.00 A. M.; Return 11.00 A. M.

July 5, Thursday—Quissett Harbor — Flats and Rocks—Digging, etc. Low tide—3.37 P. M. Start 1.30 P. M.; Return 4.30 P. M.

July 7, Saturday—Vineyard Haven Wharf Piles—Pile Scraping. Low tide—8.50 A. M. Start 8.15 A. M.; Return 11.30 A. M.

July 11, Wednesday—(omitted)

July 14, Saturday—Hadley Harbor Flats—Digging, etc. Low tide—3.01 P. M. Start 12.30 P. M.; Return 4.30 P. M.

July 21, Saturday—Dredging in Vineyard Sound. Group I—Start 9.30 A. M. Group II—Start 2.00 P. M.

July 25, Wednesday—Study of Tow in the Laboratory. Start 2.00 P. M.

July 28, Saturday—North Falmouth—Rocks, Flats—Digging, etc. Low tide—12.04 P. M. Start 9.30 A. M.; Return 4.00 P. M.

August 1, Wednesday—Nobska—Rocks, etc. Low tide—3.10 P. M. Start 1.45 P. M. Return 4.45 P. M.

August 4, Saturday—Class picnic.

Special attention has of late years been paid to the collection and identification of protozoan species from the varied fresh, brackish and salt water habitats at Woods Hole. The summarized account of results of field work has been kept for the last four years. This is a list showing the protozoa identified from eight ponds ranging, from fresh water (nos. 1, 2, 3), brackish (nos. 4, 5, 7, 8) to salt (no. 8). On each trip for the past four years the class has been divided into two groups of four teams each. Each group made collections from four of the sources listed. A very representative sampling was made as each team collected from a different region of the pond in question. Upon the return to the laboratory all samples made by each group from any given pond were put in a large clean crystallizing dish which was carefully labelled as to source of material for identification. During the study of collected protozoa all instructors were present and for each year except 1930 Dr. Mary S. MacDougall, for several years instructor in charge of the laboratory work in the Protozoology course, very kindly aided in the identification of the rarer or more difficult species. As there is not a published check list of protozoan species from these sources for the Woods Hole Region it is hoped that this list will have a definite value. The ponds are mentioned by names used by both the members of the Invertebrate Zoology and the Protozoology courses and are well known locally. Representative samples in separate clean bottles were taken by instructors from each pond during all of the years in question and pH readings were made colorimetrically immediately upon return from the trip. These readings are also given in the list. The classification used follows Calkins (1926)[12]. This list is available for consultation by workers at Woods Hole and it is proposed to leave copies of it in the Library for reference at any time.

The check list of Invertebrate species has been revised three times since 1922. The second of these revisions in 1927 was made for the purpose of bringing the nomenclature up to date and the staff was fortunate in securing for the checking of this work the services of authorities in the systematics of nearly all the phyla represented. The number of species in the present check list is 318. In the report of Sumner, Osburn and Cole[13] the total listed number of invertebrate species for the Woods Hole region is 1286. Since in the extensive work of that

* Continued from last number.

report much greater areas were covered and most of the collecting was done by dredging it is felt that in making the acquaintance of 25% of the fauna recorded in the 1911 report the members of the Invertebrate Zoology class get a fairly complete picture of the entire littoral fauna of the region. As has been emphasized before (Allee, 1922) occasionally new records for the Woods Hole region are added. What is much more valuable is the constant checking over of abundance of forms useful to the research worker. For instance, it was found during the summer of 1928 that the aberrant and interesting cirratulid worm, *Dodecaceria concharum*, was present in large numbers. This species is relatively little known at Woods Hole and had never before been identified in the work of the course. It is at present being used as research material by one of the members of the staff. Other instances similar to this can easily be cited.

The custom of providing each student with a revised check list of the species which have been taken in other years by members of the course at Woods Hole has been continued but the procedure after field trips has been considerably modified during the last eight years. Instead of writing a list on the blackboard each instructor checks over the record sheet of the day with members of his team. During this checking process any unidentified or provisionally identified specimens deemed sufficiently interesting or important to bring into the laboratory are looked at again for more complete study or final identification. Immediately after all final identifications are made the composite field record for the trip is compiled from the individual team records and posted in the laboratory. This has been done for every field trip since 1922. As a result, a check list showing at a glance the relative abundance of common littoral forms from seven different but representative localities at Woods Hole for the years 1922 to 1930, inclusive, has been compiled and copies of this list are available at any time. This list supplements the annotated catalogue made by Allee[14] ('23a) and placed by him in several institutions. The data of this list have also furnished interesting comparisons of the distribution from year to year and have furnished some evidence as to the effect of temperature on the abundance of littoral forms in this region.

As a result of past experience with the so-called "question-mark" bottle which frequently dropped entirely out of sight, or, having been filled with animals more or less mutually antagonistic was often found upon examination to contain only animal debris, the device of providing one set of bottles and vials of suitable sizes to fit into a specially constructed carrying case has been used since 1927. In such a convenient set carried by one member of the team a suitable receptacle for one or more of each species studies was provided. As a result, without waste of time, there was immediately available for further study representatives of the entire list checked in the field by any team. During 1928 for example, following the North Falmouth field trip a special demonstration of representative species, about 150 in number, was made in the entrance hall of the new main building. This representative collection of species from the richest collecting area in the vicinity of Woods Hole received a very careful inspection and several requests were made by research workers for the use of extra specimens.

Two important modifications closely related to the field work have been made in recent years. Beginning in the year 1923 members of the class made individual studies of selected areas of Quissett Harbor. This region was surveyed and an outline map drawn to scale by Drs. D. B. Young and J. A. Dawson. On this map the areas were outlined and assigned to small groups of members of the class. A selected list of 50 to 60 representative species taken in previous field trips at this locality was made and students were required to check quantitatively the distribution of these within the given area. The combined reports were kept as a matter of record. This ecological field work was done during the latter half of the course at which time each student was familiar, from previous field trips and from study in the laboratory with all the species on the list. No supervision on the part of the instructors was practised but the entire work lasting usually about two weeks, was left to the initiative of individual members of each team. It was felt that this independent work on the part of students formed a valuable part of a course in which initiative on the part of the students is encouraged in all aspects of class work.

During the years 1927 and 1928 a modification of this type of work was made. A list of species, one for each member of the class was chosen from the field check list. Forms occurring relatively rarely were avoided but from those found fairly frequently a careful selection was made. Especially inclusions of species which offer special difficulties in field identification were made. One species was assigned to each member of the class after the second week

THE COURSE IN INVERTEBRATE ZOOLOGY AT THE MARINE BIOLOGICAL LABORATORY*

DR. JAMES A. DAWSON
Assistant Professor of Zoology, College of the City of New York
Director of the Course

Field Work: This has always been emphasized in this course and, it is felt, rightly so. In the field the student sees the animal in its normal surroundings and the greatest freedom is given for the study of any phase of the activities of marine littoral animals. The organization of the field work has so far as the equipment, method of division of the class under instructors and localities visited, been continued largely as described in Allee's account. In 1926 Crane's wharf was removed and field trips to Nobska or Quissett have been substituted.

As an illustration of the schedule of field trips that of 1928 is given. Those of the other years are essentially similar, the only differences being the different dates and occasionally somewhat different localities, both occasioned by local conditions of tide or weather.

Field Trip Schedule for 1928

June 30, Saturday — Protozoa Collecting Trip—Fresh, Brackish and Salt Water. Start 9.00 A. M.; Return 11.00 A. M.

July 5, Thursday—Quissett Harbor — Flats and Rocks—Digging, etc. Low tide—3.37 P. M. Start 1.30 P. M.; Return 4.30 P. M.

July 7, Saturday—Vineyard Haven Wharf Piles—Pile Scraping. Low tide—8.50 A. M. Start 8.15 A. M.; Return 11.30 A. M.

July 11, Wednesday—(omitted)

July 14, Saturday—Hadley Harbor Flats—Digging, etc. Low tide—3.01 P. M. Start 12.30 P. M.; Return 4.30 P. M.

July 21, Saturday—Dredging in Vineyard Sound. Group I—Start 9.30 A. M. Group II—Start 2.00 P. M.

July 25, Wednesday—Study of Tow in the Laboratory. Start 2.00 P. M.

July 28, Saturday—North Falmouth—Rocks, Flats—Digging, etc. Low tide—12.04 P. M. Start 9.30 A. M.; Return 4.00 P. M.

August 1, Wednesday—Nobska—Rocks, etc. Low tide—3.10 P. M. Start 1.45 P. M. Return 4.45 P. M.

August 4, Saturday—Class picnic.

Special attention has of late years been paid to the collection and identification of protozoan species from the varied fresh, brackish and salt water habitats at Woods Hole. The summarized account of results of field work has been kept for the last four years. This is a list showing the protozoa identified from eight ponds ranging, from fresh water (nos. 1, 2, 3), brackish (nos. 4, 5, 7, 8) to salt (no. 8). On each trip for the past four years the class has been divided into two groups of four teams each. Each group made collections from four of the sources listed. A very representative sampling was made as each team collected from a different region of the pond in question. Upon the return to the laboratory all samples made by each group from any given pond were put in a large clean crystallizing dish which was carefully labelled as to source of material for identification. During the study of collected protozoa all instructors were present and for each year except 1930 Dr. Mary S. MacDougall, for several years instructor in charge of the laboratory work in the Protozoology course, very kindly aided in the identification of the rarer or more difficult species. As there is not a published check list of protozoan species from these sources for the Woods Hole Region it is hoped that this list will have a definite value. The ponds are mentioned by names used by both the members of the Invertebrate Zoology and the Protozoology courses and are well known locally. Representative samples in separate clean bottles were taken by instructors from each pond during all of the years in question and pH readings were made colorimetrically immediately upon return from the trip. These readings are also given in the list. The classification used follows Calkins (1926)[12]. This list is available for consultation by workers at Woods Hole and it is proposed to leave copies of it in the Library for reference at any time.

The check list of Invertebrate species has been revised three times since 1922. The second of these revisions in 1927 was made for the purpose of bringing the nomenclature up to date and the staff was fortunate in securing for the checking of this work the services of authorities in the systematics of nearly all the phyla represented. The number of species in the present check list is 318. In the report of Sumner, Osburn and Cole[13] the total listed number of invertebrate species for the Woods Hole region is 1286. Since in the extensive work of that

* Continued from last number.

report much greater areas were covered and most of the collecting was done by dredging it is felt that in making the acquaintance of 25% of the fauna recorded in the 1911 report the members of the Invertebrate Zoology class get a fairly complete picture of the entire littoral fauna of the region. As has been emphasized before (Allee, 1922) occasionally new records for the Woods Hole region are added. What is much more valuable is the constant checking over of abundance of forms useful to the research worker. For instance, it was found during the summer of 1928 that the aberrant and interesting cirratulid worm, *Dodecaceria concharum*, was present in large numbers. This species is relatively little known at Woods Hole and had never before been identified in the work of the course. It is at present being used as research material by one of the members of the staff. Other instances similar to this can easily be cited.

The custom of providing each student with a revised check list of the species which have been taken in other years by members of the course at Woods Hole has been continued but the procedure after field trips has been considerably modified during the last eight years. Instead of writing a list on the blackboard each instructor checks over the record sheet of the day with members of his team. During this checking process any unidentified or provisionally identified specimens deemed sufficiently interesting or important to bring into the laboratory are looked at again for more complete study or final identification. Immediately after all final identifications are made the composite field record for the trip is compiled from the individual team records and posted in the laboratory. This has been done for every field trip since 1922. As a result, a check list showing at a glance the relative abundance of common littoral forms from seven different but representative localities at Woods Hole for the years 1922 to 1930, inclusive, has been compiled and copies of this list are available at any time. This list supplements the annotated catalogue made by Allee[14] ('23a) and placed by him in several institutions. The data of this list have also furnished interesting comparisons of the distribution from year to year and have furnished some evidence as to the effect of temperature on the abundance of littoral forms in this region.

As a result of past experience with the so-called "question-mark" bottle which frequently dropped entirely out of sight, or, having been filled with animals more or less mutually antagonistic was often found upon examination to contain only animal debris, the device of providing one set of bottles and vials of suitable sizes to fit into a specially constructed carrying case has been used since 1927. In such a convenient set carried by one member of the team a suitable receptacle for one or more of each species studies was provided. As a result, without waste of time, there was immediately available for further study representatives of the entire list checked in the field by any team. During 1928 for example, following the North Falmouth field trip a special demonstration of representative species, about 150 in number, was made in the entrance hall of the new main building. This representative collection of species from the richest collecting area in the vicinity of Woods Hole received a very careful inspection and several requests were made by research workers for the use of extra specimens.

Two important modifications closely related to the field work have been made in recent years. Beginning in the year 1923 members of the class made individual studies of selected areas of Quissett Harbor. This region was surveyed and an outline map drawn to scale by Drs. D. B. Young and J. A. Dawson. On this map the areas were outlined and assigned to small groups of members of the class. A selected list of 50 to 60 representative species taken in previous field trips at this locality was made and students were required to check quantitatively the distribution of these within the given area. The combined reports were kept as a matter of record. This ecological field work was done during the latter half of the course at which time each student was familiar, from previous field trips and from study in the laboratory with all the species on the list. No supervision on the part of the instructors was practised but the entire work lasting usually about two weeks, was left to the initiative of individual members of each team. It was felt that this independent work on the part of students formed a valuable part of a course in which initiative on the part of the students is encouraged in all aspects of class work.

During the years 1927 and 1928 a modification of this type of work was made. A list of species, one for each member of the class was chosen from the field check list. Forms occurring relatively rarely were avoided but from those found fairly frequently a careful selection was made. Especially inclusions of species which offer special difficulties in field identification were made. One species was assigned to each member of the class after the second week

ITEMS OF INTEREST

Some of the students in the Course in Embryology will be interested in opportunities to remain as assistants during August. If any investigators desire to make such an arrangement they may communicate with Dr. H. B. Goodrich, Room 210 Br. 210. The course closes Saturday July 25 and arrangements should be made as soon as possible.

Catalogs of chemicals and apparatus may be obtained from the Apparatus Room of the Marine Biological Laboratory which is in Room 216 of the Brick Building. The Chemical Room can not loan its catalogs, because it needs them continually for reference work.

Miss Jeannette Hegner has been awarded a fellowship to study history in Rome. She is going this Fall and will be abroad a whole year.

Dr. Hettie Chute has been promoted from instructor to assistant professor of botany at the New Jersey College for Women.

Mr. Herbert H. Harris, who took the course in physiology at the Laboratory in 1928, and Walter Garrey, visited Woods Hole for several days. They are spending their brief vacation in their boat, taking various cruises to the south of the Cape and up around the north shore. Both men graduated from Harvard Medical School (Mr. Garrey, *cum laude*) and they will begin their internships next year. Mr. Harris goes to Presbyterian Hospital in New York, and Mr. Garrey to the Massachusetts General Hospital.

MT. DESERT ISLAND BIOLOGICAL LABORATORY

The annual Laboratory picnic was held at the home of Dr. and Mrs. Warren H. Lewis on the Fourth of July.

The first lecture in the Popular Lecture Course will be given on July 16th, by Professor Ulric Dahlgren of Princeton University. His subject is "Electric Fishes". The second lecture will be on "Inflammation" and will be given by Dr. Joseph McFarland of the University of Pennsylvania.

The first seminar of the season will be held on Monday, July 13th. Dr. Homer W. Smith of New York University will describe his experiences in Siam and Malaysia. Lantern slides will be used.

Dr. James Murray of the Jackson Memorial Laboratory, Bar Harbor, gave the second seminar in the Jackson Memorial Laboratory series, July 1st. Dr. Murray spoke on "The Effects of Inbreeding Mice."

FRANCES R. SNOW,
Laboratory Secretary.

The Zoological Field Laboratory, conducted by the University of Kentucky, will not be in operation for the next two years, owing to absences on leave of members of the staff who conduct the station.

On his return from Nantucket, where he attended a meeting of the Social Science Research Council, Dr. Adolf Meyer, professor of psychiatry at Johns Hopkins University spent a day visiting several members of the Laboratory.

Father P. H. Yancey, who was an investigator at the Marine Biological Laboratory last summer, received his doctor's degree at St. Louis University in June, He has been appointed professor of biology and director of the department at Spring Hill College, Mobile, Alabama.

The group of workers from the Johns Hopkins University gathered for a picnic on one of the beaches in West Falmouth on the evening of Saturday, July 4th.

Visitors to Woods Hole with out-of-state cars who expect to remain for a period of more than thirty days are required to secure a special permit, according to a new law in Massachusetts. The permit is free but each operator of a car is required to give evidence of holding a personal liability insurance. Blanks to be used in applying for the special permit will be available at the Administration Office in the laboratory.

CORNELL UNIVERSITY BIOLOGICAL STATION

Dr. Helen R. Murphy (Cornell '20) is in residence for a few weeks while finishing two papers: "Observations and Morphology of the Horned Toad" and "Notes on the Salpugids." The work for these was carried on in Albuquerque, New Mexico. Dr. Murphy leaves the last of July for China where she is going for a three year period to teach at Ling-nan College, Canton.

Mr. F. R. Petherbridge, entomologist of Cambridge, England, has been visiting the Departments of Entomology and Plant Pathology.

Dr. Gordon F. Ferris, Professor of Zoology at Stanford University, called at the Entomology Department when in Ithaca recently for the reunion of the Telluride Association.

Prof. A. H. Wright who is conducting the West Virginia Traveling Summer School in Zoology has returned for the opening of the Cornell Summer Session. Mrs. Wright and Dr. W. J. Hamilton, Jr. will lead the group in Dr. Wright's absence.

ELSIE BROUGHTON KLOTS,
Instructor in Limnology.

ITEMS OF INTEREST

Some of the students in the Course in Embryology will be interested in opportunities to remain as assistants during August. If any investigators desire to make such an arrangement they may communicate with Dr. H. B. Goodrich, Room 210 Br. 210. The course closes Saturday July 25 and arrangements should be made as soon as possible.

Catalogs of chemicals and apparatus may be obtained from the Apparatus Room of the Marine Biological Laboratory which is in Room 216 of the Brick Building. The Chemical Room can not loan its catalogs, because it needs them continually for reference work.

Miss Jeannette Hegner has been awarded a fellowship to study history in Rome. She is going this Fall and will be abroad a whole year.

Dr. Hettie Chute has been promoted from instructor to assistant professor of botany at the New Jersey College for Women.

Mr. Herbert H. Harris, who took the course in physiology at the Laboratory in 1928, and Walter Garrey, visited Woods Hole for several days. They are spending their brief vacation in their boat, taking various cruises to the south of the Cape and up around the north shore. Both men graduated from Harvard Medical School (Mr. Garrey, *cum laude*) and they will begin their internships next year. Mr. Harris goes to Presbyterian Hospital in New York, and Mr. Garrey to the Massachusetts General Hospital.

MT. DESERT ISLAND BIOLOGICAL LABORATORY

The annual Laboratory picnic was held at the home of Dr. and Mrs. Warren H. Lewis on the Fourth of July.

The first lecture in the Popular Lecture Course will be given on July 16th, by Professor Ulric Dahlgren of Princeton University. His subject is "Electric Fishes". The second lecture will be on "Inflammation" and will be given by Dr. Joseph McFarland of the University of Pennsylvania.

The first seminar of the season will be held on Monday, July 13th. Dr. Homer W. Smith of New York University will describe his experiences in Siam and Malaysia. Lantern slides will be used.

Dr. James Murray of the Jackson Memorial Laboratory, Bar Harbor, gave the second seminar in the Jackson Memorial Laboratory series. July 1st. Dr. Murray spoke on "The Effects of Inbreeding Mice."

FRANCES R. SNOW,
Laboratory Secretary.

The Zoological Field Laboratory, conducted by the University of Kentucky, will not be in operation for the next two years, owing to absences on leave of members of the staff who conduct the station.

On his return from Nantucket, where he attended a meeting of the Social Science Research Council, Dr. Adolf Meyer, professor of psychiatry at Johns Hopkins University spent a day visiting several members of the Laboratory.

Father P. H. Yancey, who was an investigator at the Marine Biological Laboratory last summer, received his doctor's degree at St. Louis University in June, He has been appointed professor of biology and director of the department at Spring Hill College, Mobile, Alabama.

The group of workers from the Johns Hopkins University gathered for a picnic on one of the beaches in West Falmouth on the evening of Saturday, July 4th.

Visitors to Woods Hole with out-of-state cars who expect to remain for a period of more than thirty days are required to secure a special permit, according to a new law in Massachusetts. The permit is free but each operator of a car is required to give evidence of holding a personal liability insurance. Blanks to be used in applying for the special permit will be available at the Administration Office in the laboratory.

CORNELL UNIVERSITY BIOLOGICAL STATION

Dr. Helen R. Murphy (Cornell '20) is in residence for a few weeks while finishing two papers: "Observations and Morphology of the Horned Toad" and "Notes on the Salpugids." The work for these was carried on in Albuquerque, New Mexico. Dr. Murphy leaves the last of July for China where she is going for a three year period to teach at Ling-nan College, Canton.

Mr. F. R. Petherbridge, entomologist of Cambridge, England, has been visiting the Departments of Entomology and Plant Pathology.

Dr. Gordon F. Ferris, Professor of Zoology at Stanford University, called at the Entomology Department when in Ithaca recently for the reunion of the Telluride Association.

Prof. A. H. Wright who is conducting the West Virginia Traveling Summer School in Zoology has returned for the opening of the Cornell Summer Session. Mrs. Wright and Dr. W. J. Hamilton, Jr. will lead the group in Dr. Wright's absence.

ELSIE BROUGHTON KLOTS,
Instructor in Limnology.

THE WOODS HOLE LOG

In the June 27th issue of The Collecting Net the account of the Coast Guard included the story of a green sloop reported stolen by Howard Rynard and found by the Coast Guard off Hyannis. Maskus Seralis, who was in charge of the sloop when she went aground and was arrested as a suspicious character, was released when it was discovered that he had been granted permission to take the boat by one of Rynard's friends.

Seralis' affair with the Coast Guard is not yet over for on July 4th he claims that he was insulted, that his clothing was torn, and that he was thrown into the water by a member of the Cuttyhunk Coast Guard Station, probably as a result of a quarrel over his earlier trouble with the Coast Guard. Commander Patch here has received the following letter, which seems of sufficient interest to reprint:

July 6, 1931.

My Dear Commander: I respectfully appeal to you by mail as I have taken the pleasure and courage to write all my complaints and true story as it is and as follows. On Saturday, July 4 at the Cuttyhunk bathing beach I was insulted by a member of the Coast Guard in the presence of his mate and civilians. However his name can be traced through his captain, Mr. Sanborn who is in charge. Besides names and threats my personal damage in clothes torn besides throwing me overboard I estimate and claim $30 from his pay. I wish to state also that I personally did my very best to avoid this and further trouble but my main and only cause is to give this man still another chance to make good for he may be young and foolish as he is.

Though we ought young and old, be proud of our fathers and mothers, it makes no difference what nationality we may be but the mighty and respectable nation of the United States of America with its old glory and eagle flying should at all times be respected by its citizens or aliens. As I am now doing my duty and living the life of a civilian.

Thanking you in advance Mr. Commander, as I am in hopes you will take care of this case in time for correction and my rights.

Respectfully and sincerely I remain

Yours truly,

MASKUS D. SERALIS Mate

Schooner Ada Shull.

Nantucket, Mass.

Commander Patch is turning over the case to District Commander James S. Phillips to be investigated.

Miss Charlotte Griffin of Woods Hole, a Junior at Pembroke College, Brown University, has resumed for the summer her position in the telegraph office.

The Woods Hole Yacht Club held its first race of the season on Wednesday, July 8th, starting from the Frost boat house at five o'clock in the afternoon.

The schedule of the races was as follows:

Baby Knock-Abouts

Entries	Time
"Adios"—Morris Frost	1:55
"Porpoise"—Comstock Glaser	1:57
"Tyro"—Mrs. Crossley	1:59
"Scuttlebutt"—Preston Copeland	2:31
"Menidia"—Fred Copeland	2:44
"Charlog"—Ogden Woodruff	did not finish

Dories

No one finished in this race on account of fog.

"Dorine"—George Clowes
"Aunt Addie"—Art Meigs
"Black Cat"—Vera Warbasse
"Dunky"—Kenneth Cole

Catboats, Etc.

"Lurline"—Philip Woolworth	1:43
"Squido"—Henry Kidder	2:27
"Salty Dog"—Tom Ratcliffe	2:51
"H. C."—Lewis Perrine	did not finish

The Club plans to hold races each Monday afternoon throughout the summer.

This week the University Players at Silver Beach have been featuring the well-known melodrama, "Interference" by Roland Pertwee and Harold Dearden. The play tells the story of Lady Marley whose happy second marriage veers toward destruction when her first husband, whom she believed dead, reappears, and the only woman who knows of the situation seeks vengeance through blackmailing. Around this frayed plot, the authors have built a structure which includes all the tricks of the stage; a take-off of reporters; a variety of the eternal triangle; a murder; and the process of crime detection.

Although the play dragged at the start and moved too slowly in parts, notably when Sir John Marley held the stage, it gave excellent opportunity for delightful bits of character portrayal. Particularly outstanding were the acting of Frieda Altman as Lady Marley; the clever work of Peter Wayne, dashing young hero of "Paris Bound" last weeb, whose excellent portrayal of the returned first husband left nothing to be desired; and such minor bits as Fred the hall boy and Dr. Puttock, ably acted by Myron McCormick and Alfred Dalrymple respectively.

Next week the Players are putting on Milne's comedy "Mr. Pim Passes By." —M. S. G.

THE COLLECTING NET

Vol. VI. No. 4 SATURDAY, JULY 18, 1931 Annual Subscription, $2.00
Single Copies, 25 Cts.

HUMORAL AGENTS IN NERVOUS ACTIVITIES WITH SPECIAL REFERENCE TO THE CHROMATOPHORES

DR. G. H. PARKER
Professor of Zoology, Harvard University

I am sure it was a great pleasure to us to hear Dr. Wilson at the first lecture. He is far and away the senior zoologist of us all, and it is always a matter of delight when he is willing to talk to us from his rich store of knowledge. In this series of lectures I am his unworthy successor.

You all know that the nervous system of higher animals is commonly divided into three parts; the receptors, or organs which have to do with reception of impulses from the environment; the central nervous system, which is an adjustor; and finally, the effectors, the organs whereby the animal can respond to the environment. I wish to talk to you about a particular group of effectors.

First I might recall briefly that there are numerous animal effectors. The elementary ones are, first, the urticators, or stinging cells, which occur in (Continued on page 96)

M. B. L. Calendar

TUESDAY, JULY 21, 8 P. M.

Seminar. Dr. S. Morgulis, "The Chemistry of Bone Ash."

Dr. J. M. Johlin, "The Enolization of Gelatin by Neutral Salts."

Dr. E. S. Guzman Barron, "Oxidations produced by Gonococci."

Dr. Shiro Tashiro and Mr. L. H. Schmidt, "Bile Salts."

FRIDAY, July 24, 8 P. M.

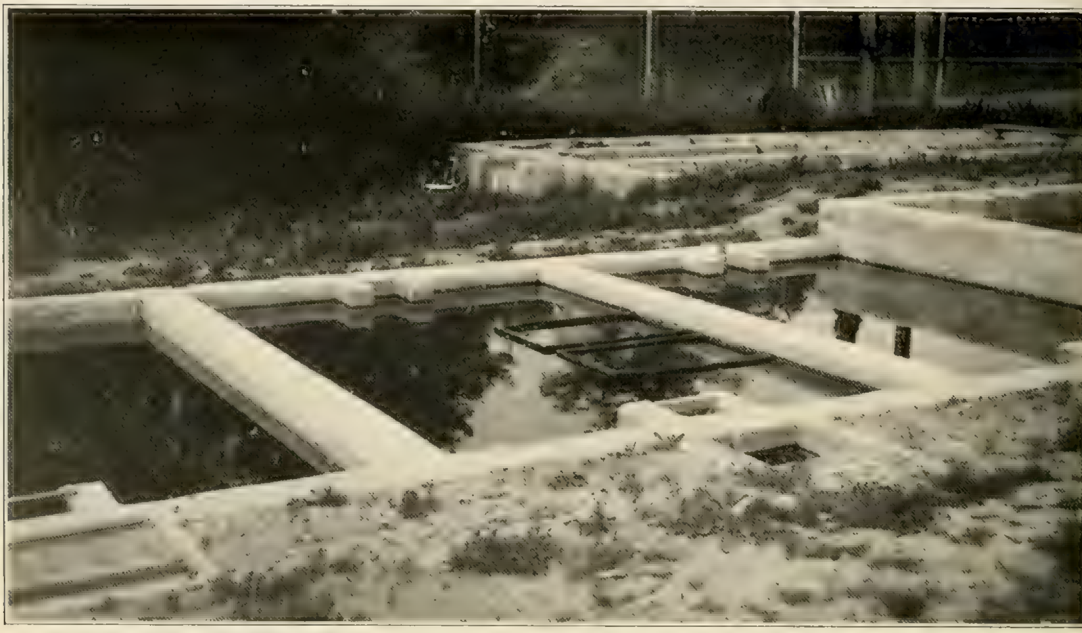
Lecture. Dr. T. H. Morgan, professor of biology, California Institute of Technology, "The Marine Laboratories of the World and their Work." (Illustrated.)

THE BIOLOGICAL FIELD STATION AT CORNELL UNIVERSITY

DR. JAMES G. NEEDHAM
Professor of Entomology and Limnology

Times have changed. For many years we at Cornell University tried to maintain a biological field station like the others in this country, with a well equipped laboratory by the waterside. Then the building burned down; and before we could get another we began to realize that the automobile had changed conditions for us; that we could now get from our best collecting grounds to the University in a few minutes; that there was no need to try to duplicate our regular laboratories, which would always be better equipped and more comfortable; and that by using the automobile freely we could better draw upon the variously distributed resources of our rich environment. So our present plans contemplate keeping in the field only the equipment needed for field work, and keeping it not in one place only, but in several places.

TABLE OF CONTENTS



DOPHINA PROPAGATING POOLS AT THE EXPERIMENTAL HATCHING STATION
These pools are fertilized and planted in succession and the crop of dophinas when grown is flushed at intervals of a few days into a lower bass fry pool.

Our plans have in part been realized. Our campus is traversed by two clear-flowing permanent streams. On one of these, Cascadilla Creek, there is located the Fish Cultural Experiment Station that Dr. G. C. Embody has developed. The ponds of this station are an inexhaustible source of biological materials. On the other stream, Fall Creek, and not far from our laboratories, is located a pump house and rearing station. Here are troughs of running water and rearing cages for lotic organisms, and here is the electric pump that supplies untreated water to our insectary on the hill above. In the insectary also are facilities for our work with aquatic insects. These places are the chief repositories of living material brought in from more remote collecting places in the field. In these much of our research is done.

We have as yet no permanent field station on Cayuga Lake for general biological use, though one is contemplated; but for work with birds we have a Fuertes Memorial Bird Sanctuary in charge of Dr. A. A. Allen; and adjacent thereto is the Cayuga Bird Park maintained by the City of Ithaca in a 50 acre tract of rich bottom land woods.

Another Field Station that is, by the courtesy of the U. S. Bureau of Fisheries, available for research work in aquiculture, is the federal fish hatchery, located on some very large springs (Gyrinophilus Springs) tributary to Upper Fall Creek, some fifteen miles north east of Ithaca. This is in purpose a research station, rather than an ordinary fish hatchery.

We have three nearby wild life preserves that have been presented by the heirs of Mr. C. G. Lloyd to the University on terms that provide for their maintenance in a state of nature. One of these near McLean, N. Y., is a wooded tract of 81 acres, containing a number of cold sphagnum bogs whose fauna and flora are largely Canadian. Another is a wild flower preserve near Slaterville Springs. It is a tract of 436 acres of rocky hills covered with maple and beech woods, and intersected by beautiful trout streams. The third is a wooded morainal tract of 110 acres of rolling hills with kettle holes holding shady pools having varying degrees of permanence. These supply some very interesting Phyllopods and other Crustaceans.

All these preserves, and three state parks as well, are within walking distance of the University (though nowadays nobody walks). All being on good roads they are easily and quickly reached and their biological resources are therefore very accessible. The three parks all contain high waterfalls of singular beauty, and the deep gorges below the falls have a rich and very interesting fauna and flora. And, happily, the Finger Lakes Park Commission, that has them in charge, has been unusually successful in its efforts to preserve the life in them from destruction by careless visitors.

With this sort of environment, with all the variety of unspoiled nature at our very doors, we would surely be neglectful of our opportunities if we did not lay some emphasis on field work at Cornell University. Especially is this true of work with aquatic animals; for we have nearby us bodies of water varying in size from a deep lake (Cayuga having a maximum depth of 435 ft.) to transient pools; we have both head water bogs and flood plain marshes; we have permanent streams of every degree of swiftness with half a dozen fine water falls on the campus itself; and we have springs both fresh and salt. Since these waters have suffered very little from pollution of any sort, their fauna and flora are rich and varied.

So at Cornell University we are able to live at home during the summer while working in the field. There is no distinction between the work of the summer and that of the academic year; for it runs the year round continuously. In order to help more effectively with field work Professor J. G. Needham continues in residence during the summer, teaching no classes, but giving his time to directing the research work of graduate students. Professors Johannsen, Matheson, Allen and Claassen also give time to graduate work while teaching in the summer session.

During the summer of 1931 half a dozen graduate students will be absent, engaged in the biological work of various stream surveys. A partial list of the workers in residence and of their seasonal problems is as follows:

Professor J. G. Needham: Mayfly ecology.

Professor O. A. Johannsen: Biology of *Chironomidae*.

Professor P. W. Claassen: Life Histories of *Plecoptera*.

Professor R. Matheson: Biology of the *Culicidae* and *Simuliidae*.

Professor A. A. Allen: Propagation of the Ruffled Grouse, and Life Histories of N. A. birds.

Mr. Wm. O. Sadler: Quantity Production of *Chironomus*.

Miss J. B. Traver: Taxonomy of the *Ephemeridae*.

Mrs. A. B. Klots: Deep water Crustacea of Cayuga Lake.

Mr. G. T. Lew: The Topography of the Head in *Odonata*.

Mr. Y. C. Hsu: The Biology of the Mayfly Genus *Heptagenia*.

Mr. M. T. Cheo: The Coleopterous family, *Gyrinidae*.

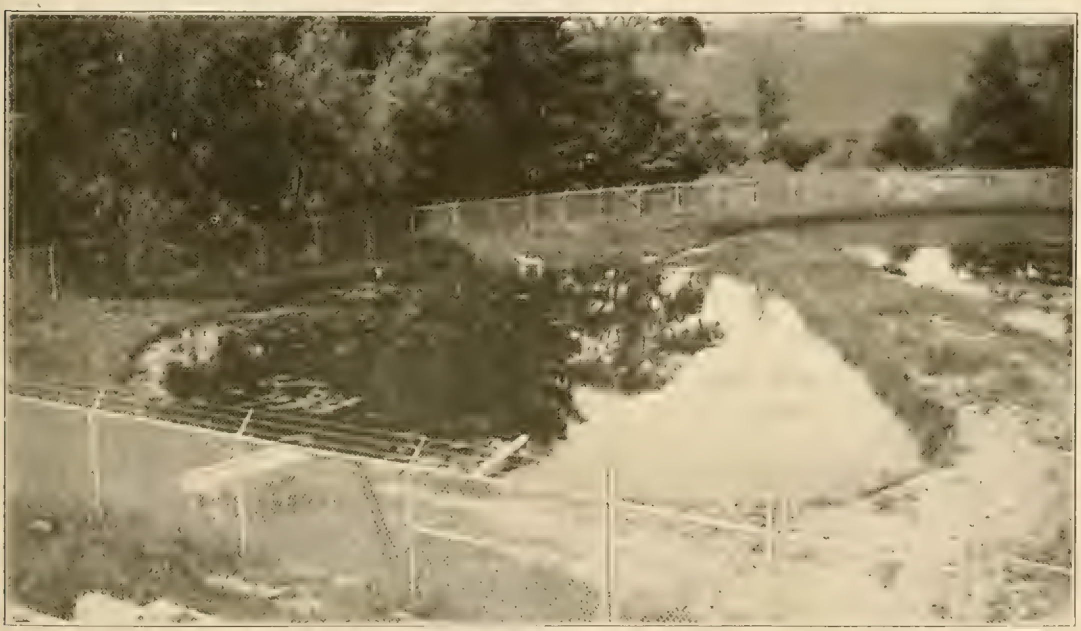
Mr. H. T. Feng: The Biology of the *Dytiscidae*.

Mr. Geo. B. Saunders: A Biological Study of the Meadow Lark.

Mr. W. A. Walter: A Biological Study of Marsh Wrens.

Miss Emma Davis: A Biological Study of the Killdeer.

Mr. Paul Kellogg: A Distributional Study of the Birds of the Cayuga Lake Basin.



ONE OF THE BASS PONDS AT THE EXPERIMENTAL HATCHING STATION

HUMORAL AGENTS IN NERVOUS ACTIVITIES WITH SPECIAL REFERENCE TO THE CHROMATOPHORES

(Continued from page 93)

the jelly-fishes and the like; and next, the glands; the luminous organs; the chromatophores, or cells which change the color of animals; the cilia, organs of movement; muscles, the typical effectors of the animal kingdom; electric organs, etc. No animal has a full range of such effectors. The frog, as you see here on the first slide, has glands, chromatophores, cilia, muscles; human beings have glands, cilia, muscles. It is a strange coincidence that the earthworm and human being have the same sets.

Our full response to the environment is carried out by these three sets of effectors. Glands are concerned with secretions for the most part. They play no obvious role in our external relations, save, for example, as tears express emotion. Our cilia are mainly concerned with keeping the chambers of the body clear. We depend chiefly on the muscles for our responses. Practicaly everything we do in response to our environment depends upon the muscles. As I am talking to you I am making use of muscular responses. My voice comes to you by reason of my breath passing over my vocal cords and my lips form words which are supposed to excite in your mind something of the ideas I am trying to express. These are all muscular operations. Muscles do everything; they enable us to dig trenches; to carve statues; they run the whole gamut of our activities. Even our expressions are due to the play of muscles. Perhaps you have what is known as a "poker face." That means that in an unconscious way you are able to control your facial muscles. We learn to read such manifestations with a skill we scarcely understand. We pay big prices to go to the theatre to see people play with their muscles in this way and we shed tears in response to the actor's artificial play with these effectors.

The particular group of effectors I want to talk about is the chromatophores. They are found in the Cephalopods, in Crustacea, and in the water inhabiting vertebrates. The squids have a wonderful play of color; their external color is due to chromatophores.

The next slide which we shall see is of an ordinary devil fish. The differences of light and dark color are due to the contraction or expansion of the chromatophores. The next figure shows the resting stage, the light condition where the chromatophore is a sphere with a great number of muscle fibers running out from it. They pull the sphere out into a flat disk and spread it over a large area. The chromatophores are really organs, in the technical sense. They have a system of innervated muscle fibers. The simplified types of chromatophores are single cells and are capable of changing color. Most fishes are capable of color change in this way.

This figure shows the chromatophores of Fundulus both in the contracted and the expanded states. The next will show you some sketches from Pouchet, who, back in the 70's studied these chromatophores in fishes. Along in the 90's Ballowitz demonstrated that there were really nerve fibers which control the activities of these organs. The next figure shows you a flat fish in two positions; in the first instance it is on a dark background; in the second case the fish reproduces not only the lightness or darkness of the surroundings, but it reproduces the pattern of its surroundings likewise. Like its background, it is more or less mottled. These animals have a control over the chromataphores which is not a common control over the whole body, but something like our muscular control. They can expand their spots or contract them in such a way as to bring about an imitation of their surroundings.

The next slide shows you an experiment with a checkerboard pattern. The fish could not quite accomplish that, but nevertheless gives a spotting that is fairly accurate. The next shows you other patterns, coarse and fine checkerboards. The animal also can not imitate these exactly but it conforms fairly well to its background. It seems impossible to regard this as due to anything else but nerve control of the elements concerned. I believe, therefore, that fishes possess this capacity as a result of nerve control of their chromatophores.

Colors may likewise be controlled by injecting various materials into a fish. If, for example, adrenalin is injected, the chromatophores contract and the fish goes into the light stage. We know that humoral influences likewise affect these organs. In general, however, we see that these changes in the fishes are essentially nervous changes.

When we consider frogs and other Amphibia, but particularly frogs, we find a remarkable and disturbing condition. Many experimenters were convinced that the nerves act on the chromatophores of the frog, but they never brought forth any real evidence. It is chiefly due to Hogben and his co-workers that we are now convinced that color change in the frog is quite different from that in the fish.

The next slide will show you the two conditions —light and dark,—and the following will demonstrate the chromatophores in the skin. The three conditions, contracted, intermediate, and expanded are shown. Nerves may be cut, and no difference

whatever can be noted. This condition does not, therefore, depend upon the nerves. Hogben pointed out that the dark condition in the frog was probably brought about by pituitary secretion. When the pituitary glands were removed the frog went into the light state and remained light permanently. Pituitary secretions poured into the blood causes the darkening and its absence the light coloration. This state, therefore, is one in which the animal as a whole changes and cannot change in pattern.

Two years ago I experimented with tree toads by putting them on checkerboard patterns, but could get no evidence of change of color other than that of the whole pattern of the animal. It therefore appears that the Amphibia are humoral in their response.

Another group which shows color changes is the lizards, of which the chameleon is a typical animal. Hogben used the African Chameleon and cut the animal's spinal cord at different levels. These cuts induced an expanded condition of the chromatophores, and the animal, when electrically stimulated, became light or dark colored only in front of the cut. He concluded, therefore, that in the chameleon the system was under nerve control as in the fishes. The fishes, then, are predominantly nervous, Amphibia humoral, and the reptiles nervous. I think no zoologist can look upon this with complacency—there is something queer about it.

I set one of my students, Dr. Perkins, to work on Crustaceans and his studies on chromatophores proved to be extremely interesting and illuminating. The next slides show you three Crustaceans, one light and two dark; and chromatophores in various stages, expansion, contraction, and here they are contracted almost to a dot. The fully contracted condition produces the light condition in the animal. Expansion is apparently within limits. Perkins started to find out whether the control was humoral or nervous. He found it advantageous to work upon the abdomen of the animal. He made cuts on the side and from above and sets of cuts upon different animals, but the only cut that was effective was the one which severed the dorsal blood vessel. This prevented any further change in the abdomen. Perkins then opened the animal in the back, lapped over the dorsal blood vessel, and, catching it on the skin, stopped the circulation of the blood, whereupon the chromatophores ceased to change. When circulation was restored the capacity to change was recovered. There seems to be every reason to believe that in these forms something carried in the blood is responsible for changing the animal from the light to the dark condition.

What is this disturbance and where does it come from? Perkins worked on the organs in the animal's body, making extracts and injecting them into animals to see whether he could get light and dark changes. He finally fell upon the eye stalk, ground it up with seawater and then injected the material into the blood of another animal. The animal becomes light if it was dark; if it was light colored it remains light. So Perkins concluded that some substance produced in the eye stalk was effective in bringing about changes in the chromatophores. He could not find a substance which produced the dark condition.

The eye is absolutely necessary for this change. If the eye is removed the changes cease. The same is true of fishes and amphibians and lizards. If you blind an animal on one side, color changes are still possible. If you make it totally blind the color changes cease.

Koller found that if blood from one Crangon was injected into one of another color, there was a change. He succeeded in finding an organ which he claimed worked upon expansion as well as contraction. He found that eye stalks brought about contraction, as did Perkins. The next slide shows the eye stalks which produce one change, that is the light change. Here is also the organ which produces the dark change. It is a small area behind the rostrum in the head region. Its secretion, injected into the blood of an animal, will bring about the dark condition.

The next figure shows a shrimp in which the dark organ has been destroyed and one in which it has not been destroyed. When both animals are put on a background one responds to the dark and the other fails to do so. The process probably proceeds like this: we have light falling upon the eye; consequently there are nerve activities here; and somewhere perhaps in the ganglia, secretion is produced. At any rate there is nerve action to start with. This produces a substance which is carried by the blood until it comes into contact with chromatophores. There is a double action here. It is not a simple question of nervous or humoral action; it is both. The first part of the action is nervous, the last part is humoral. Neuro-humoral is therefore a term that can be applied perfectly well to Crustaceans.

In Amphibia you see exactly the same thing. The eye is necessary for the operation. The light falls on the eye from a light or dark environment. Nervous activities are started; something in the central nervous system gives off a substance which is carried in the blood and sets off a change in the chromatophores. The action here may also be said to be neuro-humoral.

Is it possible that there is a neuro-humoral state of affairs in fishes and in reptiles? If so we can call the whole system as neuro-humoral. If you think of the condition in the fish you will see at once that it is entirely possible to consider the process in these terms. The light falls on the eye of the fish; it is stimulated to nervous activity through the central apparatus, and the active sym-

pathetic fibers eventually reach the neighborhood of the chromatophores. At this point I believe there is humoral activity. That condition, so far as I know, holds for the fishes and reptiles. If we accept that view, then we can see that neuro-humoral activity is sufficient to make all of these devices work on one plan. This would clarify the situation so far as the vertebrates are concerned.

In the fishes and reptiles the nervous component is long and the humoral short; in the Amphibia there is a short nervous condition, with an extended humoral one. In a specialized animal like the flatfish the stimulation is local in character. Fraulein Mayer has found exactly that state of affairs. She drew the blood from a dark flatfish, injected it into a light flatfish and found that that spot became dark. Reciprocally a spot on the black flat fish turned light when injected with blood from a light flatfish. This shows that these samples of blood are active in the fish's body, and active locally. It is entirely possible that we may explain local color changes in this way even if they are humoral.

This neuro-humoral hypothesis assumes that the fine endings of the nerves secrete substances. That perhaps is a considerable assumption. Dr. Speidel some years ago described cells in the spinal cord of the skate which were believed to be secretory. The gland of the body which is most concerned with such changes is the adrenal and is one which secretes substances. The medulla, which secretes the adrenal fluid, is embryologically derived from the sympathetic system. What difference does it make whether we have to deal with a cell which may secrete on its own surface, or whether we are dealing with a cell which has a long process which secretes at its end? I have no difficulty in believing that nerves are secretory. I believe also that the whole nervous system may work in this way, and that such behavior is not confined to the nerves which control the chromatophores.

Other receptors may also be controlled in a neuro-humoral way.

Urticators, the netling cells of sea anemones, are non-nervous. We do not know much about the nervous control of cilia, luminous organs, and electric organs, so we have to pass these over. When we turn to the glands we find that certain ones are regularly excited by humoral influences, e. g. the pancreas. This is a straight out-and-out humoral organ. The salivary glands are particularly interesting in this respect and have been described as the typical nerve-excited glands. In 1913 Demoor carried on an experiment on these glands. He excited the salivary gland of a dog, drew off the secretion, and injected it into a quiescent dog. The second dog secreted saliva. It looks as though there were a substance there which passed into the saliva and incited response when it was secondarily injected. I believe that the nerves of the salivary gland produced a substance which excited the gland to action and some of this substance, escaping in the spittle, was capable of exciting the second dog.

A striking example among the effectors is the vertebrate heart. It can be slowed in its action by stimulation of the vagus nerve. In 1921 Loewi began a remarkable series of papers on the stimulation of the heart. He took a frog's heart and cleaned it of blood, then filled it with a certain amount of Ringer's solution. The solution was then withdrawn and set aside. He filled the heart again with Ringer's solution and when the heart again began to beat normally he stimulated the vagus nerve. The action gradually slowed He again drained off the fluid and set it aside, and restored the original Ringer's, whereupon the beat returned to normal. The second fluid was then introduced and he found that the beating of the heart was slowed.

This experiment has been repeated in many ways. It is ordinarily performed with two hearts, and the same result is obtained. There is good reason to suppose that the vagus nerve produces a substance which is carried in the blood, which will influence other organs than the heart in the same way.

An interesting case has been described in the smooth muscles affecting the hair on the tail of the cat. When the smooth muscles are excited the hairs stand up. If you arrange a cat with denervated heart, so that the adrenals and liver have no part in the circulation, and then stimulate the sympathetic fibers going to the tail, the hairs will stand up. For a few minutes after, the heart changes its beat. This is due to something which has been secreted and poured into the blood. Cannon and Bacq believe that there is a substance produced in the smooth muscles of the tail which escapes into the circulation and affects the end organ. This they have called sympathin. I asked Cannon why it might not be a secretion from the nerve endings, and he said that he had never thought of it in that way. I am inclined to believe that the nerve endings are the secretory organs

In 1924 experiments were carried out on the skeletal muscles of the frog. Here substances produced in the skeletal muscle of one frog were passed over in the blood injected into the rectum of another frog, and produced a change in the smooth muscle.

Years and years ago Botezat put forth a theory which was the neuro-humoral idea, potentially, as applied to the ordinary secondary sense cells of the vertebrate body. In the ordinary organs of taste we have this condition revealed: the nerve fiber comes down and branches in the immediate vicinity of the taste buds on the surface of the tongue. How do these cells excite the nerve

fibers which lie immediately behind them? He said "I think they act as glands. They secrete a substance." He proposed to call these cells "Sinnesdrusenzellen." That was in 1910 and no one paid much attention to the work, so it was lost sight of.

These fibers have very remarkable influences of another kind on their end organs. If nerves going to the tongue are cut, the taste buds degenerate. If it is not a part of the fiber, why does it degenerate? Some of the influence passes across from the nerve ending to the taste bud and maintains its integrity. That is a trophic influence. I don't think that there is such a thing as a tropic nerve, but I think practically all nerves have a tropic influence. When the nerves of which we are speaking regenerate, the taste buds regenerate. Some of you have heard me lecture about neurofibrils. I expressed the view that the neurofibrils were concerned with the transmission of these trophic impulses. Here, in the case of the taste buds, we have conditions occasioned by a neuro-humoral activity, nerve impulses to the interior and trophic impulses to the exterior, and all probably neuro-humoral.

The disease known as "shingles" apears in the form of bands around the body breaking out in inflammation. It was formerly thought to be a skin disease. It is now known to be due to an inflammation of the spinal ganglia of a particular region and these bands are in exact correspondence with the distribution of the sensory nerves of that particular area. The disease is probably due to abnormal secretion of nerves in that particular section. If we think of these fibers as ordinarily secreting something which keeps the skin in a normal condition, then we can understand how such an abnormal secretion will produce the disease.

In the central apparatus the main problem is the interrelation of neurones. They come together, at the synapses and impulses pass across in these regions. The remarkable fact about this is that the impulse will pass in only one direction at the synapse. It cannot be sent in a reverse direction. It appears that the synapse is polarized It takes more time for impulses to pass across a series of breaks of this kind than it would to pass along a single fiber. How does this polarization come about and how is retardation of the operation effected? Dr. Gerard has gone over this matter in a recent survey and has stated that "either the same kind of ion migration and chemical response which represents successive activation of one region of the nerve fibre by another must also take place at the synapse, or it is conceivable that the end of the axon acts as a minute gland and, when stimulated, produces some chemical which is able to excite an adjacent or neighboring dendrite." The second alternative is exactly the view I have been talking about. Time is consumed in secretion. I believe that central physiology favors this idea that the neurones are interrelated through secretion and that polarization of neurones and retardation across a synapse is due to secretion.

Dr. Bartelmez a few years ago studied gigantic synapses in the Mauthner cells of the fish but his work was largely histological. In the worms and Crustacea there are giant fibers which run the whole length of the animal's body and are supposed to be continuous. The earthworm has three of these giant fibers the shrimp four.

In 1924 Dr. Johnson of the Harvard laboratory demonstrated for the first time that these fibers are not continuous. One segment of a giant fiber overlaps the next segment, and there are as many of these overlappings as there are segments in the animal's body. They are not continuous fibers then, but are segmentally arranged. Synapses here are really gigantic and I feel justfied, therefore, in giving them a special name—macro-synapses—as contrasted with the ordinary synapses which are so small that they can scarcely be seen.

The next slide shows a cross section of the nervous system of the earth-worm. The three giant fibers are enormous. The next slide will show you a series of sections taken from a region where the overlaps occur. If you study these fibers histologically you will see first of all that they are polarized. The two ends are not alike. If you stain them in osmic acid you will find that the lateral fiber is always deeply stained. If you study their action you will find that it is that of the direction of the worm as a whole. If you stimulate the worm on the head it pulls together; if you stimulate it on the tail it pulls together. That is a continuous action of the individual. If you cut the lateral fibers and then stimulate the tail the action will run only to the cut. Corresponding experiments show the direction of the transmission in the median fiber. It is a double system of transmission. The conditions are such that the discharging portion of the neurone is dark colored, the receptive, light. The same thing is found in the shrimp. The lateral fibers are deeply colored and transmission is toward the head. The receptive portion is light and the discharging portion is stained. That shows us that these macrosynapses are chemically different on the two sides. I think this is the first time we have found evidence of such a difference. It does not prove the existence of a secretion, but I believe that a secretion is present. It does show that these giant nerve fibers have a remarkable physiological and histological polarization which is quite open to the interpretation that I have suggested.

This neuro-humoral condition is quite hypothetical, as you see, but the hypothesis seems to me suggestive and provocative of many questions. I think it likely that further study will reveal that

it is an activity of considerable importance. The French materialistic physiologists of a century and a half ago were impelled to make many radical statements. Cabanis said "The brain secretes thought as the liver secretes bile." No one believes this literally but I suspect that the nerve activity of the body is much more influenced by secretions than the modern physiologist has suspected.

REVIEWS OF THREE BOTANICAL BOOKS

Bacteriology—A Textbook on Fundamentals Stanley Thomas. Second Edition, 1931 xv plus 301 pp. McGraw-Hill Book Company, New York.

This book is not as inclusive a document as the first part of its title would suggest, nor does it limit itself to the field of bacteriology. It is a book quite evidently designed for a class of students which will not enter upon laboratory bacteriology without separate and further training. The sanitary engineer, the hygienist and the food technician will find here the information which newcomers in their fields will be expected to assimilate as the foundation for more specialized training. The professional bacteriologist in training, particularly the medical student, will find that the familiar environment of isolation and culture methods, of description of numerous pathogenic organisms with the methods for their detection, are absent or treated in generalized form, with avoidance of specific techniques. This raises in the mind of the reviewer the question of the fundamental character of the technique of a branch of science; changing tool that it is, is it not as fundamental to a proper understanding of science as the ancient history of the science.

The history of the various phases of pure and applied bacteriology receives extensive and readable exposition by the author. The discussion of classification of bacteria is adjusted to the revised understanding of that confused field now in vogue. This is as it should be, but it is unfortunate that the author should state in generalization that the genus name is usually a Latin word (p. 18), for it is generally (when not based on a personal or geographic name) of Greek origin, sometime latinized, as one may confirm in any botanical manual (such as Gray's 7th ed.) where the roots are given. Bacteriological morphology is treated in the light of the renewed acceptation of possible pleomorphic changes in the developmental course of the organism, and consequently bears a quite different and secondary relation to classification than it did for an earlier generation, and much more specific relation to life histories. It seems unnecessary to state, when discussing the size of bacteria, that (p. 59) the micron is equivalent to 1-2g,000 of an inch when it would have cost no more to print the correct figure. The discussion of the structure of the bacterial cell is full and helpful. The chapter on the physiology of these organisms likewise is well elaborated, although it attains a somewhat highly technical vocabulary in discussing the newer interpretations of bacterial heredity. The chapter on cultivation of bacteria is a generalized one, including, with the general features of growth conditions, mention of palaeobotanical records of bacterial growths and bacterial ecology, rather than culture media, isolations and such techniques. Much of the physiological distinctiveness of bacteria shows in the chapter on bacterial enzymes, and this is a particularly useful portion of the book to the worker in allied lines. Bacterial relations to the nitrogen, carbon, phosphorus and sulphur cycles in nature are elaborated here. The following chapter, ostensibly dealing with micro-organisms other than bacteria, is less fortunately presented. After short mention of viruses and Spirochaetes, attention is turned to the last four orders of the class Schizomycetes! Then follow some four pages of reference to fungi, and about three to algae. The latter portion, probably introduced out of courtesy to the student of water supplies, might better have been omitted. The author has unfortunately adopted archaic information or misinformation as if from elementary botanical textbooks. For example, he states that there are four major algal groups (p. 130) when there are nine or ten (depending on interpretation) independent groups recognized He also claims that the chlorophyll in Cyanophyceae is diffused throughout the cell (p. 130); that the genera of the Protococcales (miscalled a family) which occur in water are Pleurococcus and Volvox (p. 131) when there are dozens of others in like situations; that Laminaria reaches the phenomenal length of 800 feet or more (p. 132)—probably ten times the maximum in this genus; that the diatoms (p. 132) are members of the so-called "Brown Algae" (Phaeophyceae); and he has also taken various liberties with spelling: Oscillaria for Oscillatoria (p. 130), Coelspaerium (p. 130) and Caelosphaerium (p. 164) for Coelosphaerium, Aphanzomenon (p. 164) for Aphanizomenon, and so forth. There follow chapters on bacteria in the soil, in water, sewage, the air, foods, and in disease production, which appear to be adequately and helpfully done, as are those on immunity, sanitation, and bacteria in industry.

Lastly, the introductory chapter may receive some attention. It is designed, apparently, for those students who lack preliminary training in biology. In some parts it seems hardly quite sound, as in the description of mitosis (miscalled karyokenisis (p. 12) for karyokinesis), where an elaborate mechanism of centrosomes and asters

is involved in this generalized plan, though these structures are known in only a very few plants indeed, and where (p. 13) the longitudinal division of each chromosome involving the splitting of each chromatic granule is said to occur on "a plane perpendicular to a line drawn between the two centrosomes" when it occurred long before this period. Conjugation (p. 13) by confusion of a sexual reproduction with undifferentiated sexual reproduction is made a subdivision of the former, and the cytological history as given bears little resemblance to what is known of this process in plants. The statement on p. 16 that "Maturation or reduction division is a mitotic division with subsequent fission" likewise does not hit very near our present state of knowledge.

Fortunately the features to which the reviewer takes exception are not such as will appear important to the normal user of this book, and its obvious acceptability (as evidenced by its appearance in a second edition) for teaching purposes will outweigh these weaknesses, so long as the central material is soundly presented.

—WM. R. TAYLOR.

* * * * *

Plant Physiology. (With reference to the green plant.) Edwin C. Miller. 900 pp. McGraw-Hill Book Co., $7.00.

Dr. Miller has attempted to fill the need for a text-book in plant physiology which summarizes and brings to date work done in Europe and America.

The result is a carefully written discussion of the following topics: plant cells, absorption of water and dissolved material, water loss, photosynthesis, nitrogen metabolism, fat metabolism, digestion, translocation, respiration and growth. No discussion of reproduction or responses is included. Good literature lists accompany each discussion. At the end of each chapter is a set of questions on the material covered. These questions, together with the treatment of physiology entirely from the standpoint of green plants, seem odd in a book designed for advanced students.

The text is an excellent reference book for any one interested in physiology and, with the use of carefully selected references, supplementary lectures, and class discussions, should be well adapted for use as an advanced text in plant physiology.

—J. R. JACKSON.

* * * * *

The Lower Fungi — Phycomycetes. Harry Morton Fitzpatrick. 331 pp. (Illustrated). McGraw-Hill Book Co. $4.00.

This book will be heartily welcomed by students and research workers in mycology and plant pathology. The author has recognized and attempted to fill the need of a complete and detailed treatment of the taxonomy and morphology of the phycomycetes. In his classification of the Phycomycetes into the eight orders, namely; Chytridiales, Ancylistales, Blastocladiales, Monoblepharidales, Saprolegniales, Peronosporales, Mucorales, and Entomophthorales, the author does not depart far from the older classifications. Where changes are made, adequate explanation is given for the reason of the change. The inclusion of the Plasmodiophoracae in the Chytridiales and the establishment of the order Blastocladiales are examples of this. Keys are provided for all genera. A complete discussion of the work done on various species of a genus follows with citations to literature. Doubtful or excluded genera of an order are treated at the end of the order. In conclusion a brief and concise survey of the various views of the origin of the Phycomycetes as well as Hemiascomycetous affinities is given by the author.

Technical terms are printed in boldface type in the text at the point at which they are defined or explained. Especially desirable is the bibliography found at the end of each chapter.

—RUTH I. WALKER.

One of the two Research Corporation prizes for 1931 has been awarded to Dr. Andrew Eillicott Douglass who is director of the Steward Observatory of the University of Arizona. Besides a bronze placque he receives $2,500. Dr. Douglass has received the award for his researches on the rings marking the annual growth of trees which have thrown light on the past climate of the earth, and shown a correspondence between weather and solar activity.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the hole turns to run from Buzzards Bay to Vineyard Sound:

Date	A. M.	P. M.
July 18	7:11	7:29
July 19	8:00	8:22
July 20	8:47	9:19
July 21	9:44	10:18
July 22	10:40	11:17
July 23	11:33	.....
July 24	12:21	12:34
July 25	1:16	1:25
July 26	2:19	2:27
July 27	3:07	3:16
July 28	4:01	4:06

In each case the current changes approximately six hours later and runs from the Sound to the Bay. It must be remembered that the schedule printed above is dependent upon the wind. Prolonged winds sometimes cause the turning of the current to occur a half an hour earlier or later than the times given above.

The Collecting Net

A weekly publication devoted to the scientific work at Woods Hole.

WOODS HOLE, MASS.

Ware Cattell .... Editor

Assistant Editors

Margaret S. Griffin Mary Eleanor Brown

Annaleida S. Cattell

THE BEACH QUESTION

Our note on the beach question has brought forth a good deal of discussion. In conversation with one of the property owners bordering the beach we have learned more fully the reasons for the erection of the fence on the beach. We shall try and state them as they were understood by us:

They very much regret the necessity of closing their property to bathers. This is occasioned by the increased number of people who now come to Woods Hole. Last year they found conditions intolerable because of the noise which inevitably accompanies bathing so near the cottages and the entire loss of privacy which ensues.

They do not feel that our suggestion about permitting the adult members of the laboratories to use the beach in the day time is practical, because of the undesirability of limiting its use to them, and because even then the disturbance would be too great.

There is not the slightest desire to be discourteous nor to prevent bathing and swimming on the long stretch of beach in front of the bathhouses. The moral right lies in the desire of every person for a reasonable amount of privacy in his home and the property owners express their great appreciation for the universal observance of that this summer. The legal right is defined in the following statement, contained in a letter from the Commissioner of Public Works of the State of Massachusetts:

> "Under the laws and court rulings of Massachusetts the right of the general public to use flats privately owned is strictly limited. Persons may enter upon such flats to exercise the right of fishing, which may include the digging of clams, and may pass over the beach for the purpose of fowling. No right of the public has been established to walk upon the beach for bathing, or to remain there for play, for rest or for any other than the two purposes of fishing and fowling, and of navigation."

Our limited space makes it necessary to postpone any comment that we may have to make until the following number.

Five COLLECTING NET scholarships of $100.00 each will be available for award this summer. Any student in attendance this summer at the Marine Biological Laboratory is eligible for the award. The money is appropriated to meet a part of the expenses of the recipients at Woods Hole during the summer of 1932. Application blanks will be made available soon.

THE REPORT OF THE SPECIAL COMMITTEE OF THE CORPORATION OF THE MARINE BIOLOGICAL LABORATORY

In connection with the corporation meeting of the Marine Biological Laboratory which convenes on August 11, it is of interest to reproduce the following report of its special committee which was mailed to members during the winter:

At the Annual Meeting of the Corporation of the Marine Biological Laboratory held on August 12, 1930, a committee was appointed to study the matter of nominations of Officers and Trustees.

At the request of the Committee the following report is distributed for the information of members of the Corporation. Gary N. Calkins, Clerk.

To Members of the Corporation of the Marine Biological Laboratory:—

At the Annual Meeting of the Corporation of the Marine Biological Laboratory of August 12, 1930, it was voted that the entire matter of methods in nominating Officers and Trustees be referred for study to a Special Committee consisting of two non-Trustee members of the Corporation and two Trustees.

The existing method of selecting Officers and Trustees is based on a vote of the Corporation at the Annual Meeting in 1911, requesting the Trustees each year to submit to the Corporation at the Annual Meeting, nominations for vacancies on the Board. Trustees hold office for a term of four years normally eight such vacancies are filled by election each year. The practice has been for the Trustees to submit one name for each vacancy and until this year these nominations have been elected by the Corporation unanimously.

After careful consideration and discussion with the Executive Committee of the Trustees your Committee is prepared to make the following recommendations. In advance of the next Annual Meeting at which the final report will be made, it seems desirable to submit these recommendations to each member of the Corporation with the hope that those interested will transmit to the Chairman of the Committee, possible criticisms or suggestions for additional recommendations. The final report of the Committee will be prepared after the consideration of any such comments. The recommendations follow:

1. That the By-Laws be changed in such a manner that the individuals in charge of courses shall be Trustees ex-officio.
2. That the Committee of the Corporation for nomination of Trustees consist of five members, of whom not less than two shall be non-Trustee members of the Corporation.
3. That on or about July first of each year, the Clerk of the Corporation send a circular letter to each member giving the names of the Nominating Committee and stating that the nominating committee will be glad to receive suggestions regarding nominations.
4. That the members of the Corporation be encouraged to avail themselves of the opportunity, which has always existed but which heretofore has been little used, of bringing to the attention of the Executive Committee at any time matters which they consider to be of importance to the Laboratory.

Hubert B. Goodrich
Harold H. Plough
Ivey F. Lewis
Winerton C. Curtis, Chairman

ITEMS OF INTEREST

Dr. Douglas M. Whittaker, formerly assistant professor of zoology at Columbia University, has accepted the position of associate professor of zoology at Stanford University.

Dr. E. Alfred Wolf, assistant professor of zoology at the University of Pittsburgh, has been appointed associate professor for next year.

Dr. Ruth I. Walker, instructor in botany at the University of Wisconsin, has been placed in charge of the work in botany at the Milwaukee center of the University of Wisconsin Extension Division. Dr. Walker is carrying out her work in botanical research this summer at Woods Hole. At this same institution Dr. Donald C. Broughton has been appointed assistant professor of zoology.

Dr. T. Thomas Flynn, who is now Ralston professor of biology in the University of Tasmania, has been recently appointed to the chair of zoology in the University of Belfast.

Professor Charles W. Dodge has been made emeritus professor of biology. He has held the position as head of the Department of biology at the University of Rochester for forty-one years.

Dr. Warren S. P. Lombard, professor emeritus of physiology in the medical school of the University of Michigan has been awarded an honorary degree of doctor of science by that institution.

At the commencement exercises of Purdue University, the honorary degree of doctor of science was conferred on Dr. J. C. Arthur, professor emeritus of botany; and on Dr. Stanley Coulter who is professor emeritus of biology.

Dr. A. B. Keyes went abroad early in September of last year as a National Research Fellow. He worked with Dr. A. Krogh at the University of Copenhagen. Dr. Keys has been reappointed a fellow of the National Research Council and will spend the coming year at Plymouth and Cambridge, England.

Dr. William Crocker, director of the Boyce Thompson Institute for Plant Research, has been elected acting director and general manager of the Tropical Plant Research Foundation Dr. Crocker spent the summer of 1927 at the Marine Biological Laboratory as Chairman of the Division of biology and Agriculture of the National Research Council.

Dr. L. G. Barth has just returned from a year in Europe, where he worked at the Zoological Station in Naples and at the Kaiser-Wilhelm Institute in Berlin. He is the holder of a National Research Fellowship. Next year Dr. Barth will be an instructor at Columbia University.

MT. DESERT ISLAND BIOLOGICAL LABORATORY

The second seminar of the season will be given Monday night, July 20th, in the Dining Hall, by Dr. William H. Cole, of Rutgers University. He will talk on "Chemical Stimulation in Animals."

Miss Miriam Slack entertained the young people of the Laboratory at a picnic supper held at her summer residence on Wednesday, July 8th.

Sunday afternoon, July 12th, the young people of the Laboratory climbed the ladder trail up Newport Mountain as the guests of Miss Elizabeth Mast. The climb was followed by supper at Miss Mast's house.

The first Laboratory dance will be held in the Dining Hall, Saturday night, July 18th.

On Thursday, July 23rd, Dr. Joseph Mac-Farland, Professor of Pathology in the University of Pennsylvania Medical School, will give the 2nd lecture in the Popular Lecture Course. His subject is: "Inflammation."

Dr. Feng of the University of Ohio arrived Saturday, July 11th, to assist Dr. W. H. Cole in his work. Dr. Feng is one of the Chinese Fellows sent to this country by the Chinese Government and supported by the Boxer Indemnity Fund.

Dr. Warren H. Lewis of Johns Hopkins Medical School spoke on tissue cultures of cancer at the Jackson Memorial Laboratory, Wednesday, evening, July 8th.

Dr. Harold D. Senior visited the Harvard Medical School in Boston last week. He went especially to examine the embryos in the Harvard Medical School collection for information relative to the development of the ulnar artery.

FRANCES R. SNOW, *Secretary.*

Dr. Carl F. Cori, a member of the State Institute for the Study of Malignant Diseases (Buffalo), has been appointed professor of pharmacology at the Washington University School of Medicine.

Dr. L. J. Cole, Professor of genetics at the University of Wisconsin has recently been elected a corresponding member of the Czechoslovak Academy of Agriculture. (Continued on Next Page)

ITEMS OF INTEREST

The Collecting Net will be glad to keep on file in its office a list of names of individuals who are interested in obtaining a position for the approaching academic year. Their names and any information that they would like to leave would be made available only to those persons who might be concerned with their appointment.

Mr. Alfred L. Loomis of Tuxedo Park, New York, accompanied by Dr. Donald Christie of McGill University, has been cruising the waters around Woods Hole in his yacht in search of sharks for his experimental work on their glands. Mr. Loomis carries on experimentation at his physical laboratory in Tuxedo Park. He is visiting Dr. E. Newton Harvey.

Miss Mary L. Austin will sail for Lucknow, India, in June of 1932. She will take the place of Miss Evangeline Thillayampalam as head of the zoology department at the Isabella Thoburn College. Miss Thillayampalam will come to this country during that year to take Miss Austin's place in the zoology department at Wellesley.

Dr. M. A. Graubard, who received his degree this year at Columbia University, has been awarded a National Research Fellowship for the coming year. He sails for England the beginning of August to take up work at the University of Manchester.

Miss Molly Hassler, daughter of Mrs. Francis A. Wilson, and Dr. Thomas P. Hughes were married in New York City on July 7. Mrs. Hughes has just graduated from Cornell University, and Dr. Hughes has recently been appointed an associate member of the Rockefeller Institute.

Raymond B. Montgomery is sailing on the "Atlantis" this summer. He is helping to take water densities and doing general work in physics. He will be a senior at Harvard next year.

Dr. Cornelius M. Clapp has returned to Woods Hole from Mount Dora, Florida, where she spent the winter months.

Brooklyn College has appointed Dr. Ralph C. Benedict as associate professor of biology. He has been chairman of the department of sciences at the Haaren High Schol.

Dr. C. H Kauffman, emeritus professor of botany and emeritus director of the herbarium of the University of Michigan, died at his home in Ann Arbor on June 14.

Mr. R. L. Dufus, of the editorial staff of the New York Times, and recently appointed editor for the Committee on the Cost of Medical Care, will arrive in Wods Hole during the week of July 20 to spend several weeks with his family who are living in the Jennings cottage on Gansett Road. Mr. Dufus has written some successful novels, the most recent of which was "Tomorrow Never Comes." He is the author of "The Santa Fe Trail" and of a volume entitled "Books, Their Place in a Democracy."

Dr. Charles J. Fish, director of the Buffalo Museum of Science, has accepted charge of an international survey to determine the effect on the herring industry of the proposed power dam at Passamaquoddy Bay, Maine. Dr. Fish has received a leave of absence from the board of managers of the museum and went on July 10 to the Canadian biological laboratory at St. Andrews, N.B., the seat of the two-year investigation. He has spent several summers at Woods Hole as director of the local branch of the United States Bureau of Fisheries. Other members of the commission are: Dr. A. G. Huntsman, director of the Atlantic Botanical Station, Canada; O. E. Sette, in charge of North Atlantic investigations for the United States Bureau of Fisheries; W. A. Found, deputy minister of fisheries, Canada, and Dr. H. B. Bigelow, director of the Woods Hole Oceanographic Institution. Dr. Fish will be executive secretary of the commission and will have charge of the work in the field.

SCRIPPS INSTITUTION OF OCEANOGRAPHY

Furniture for Ritter Hall (the new laboratory building, is arriving by the car load and part of it is already being installed. There will probably be three carloads of it especially constructed in Michigan.

Dr. T. D. Stewart of the Department of Chemistry of the University of California at Berkeley visited the Institution on Monday of this week.

Mr. M. L. Natland of Long Beach, California, who for several years has been making a comparative study of fossil and recent foraminifera visited the Institution on Monday of this week to consult Director T. W. Vaughan about a special program of investigations which he is undertaking this summer. The plans, concerning which he wished to get most advice, involve the dredging of approximately two hundred samples of sea bottom from shallow to deep waters between Long Beach and Catalina Island. For this part of his program he has been granted a special aid fund by the National Research Council.

THE WOODS HOLE LOG

The Woods Hole Library has recently been the recipient of seven books presented by Dr. and Mrs. Alfred Meyer in memory of their brother Harry Harvey Meyer, on his birthday, June 29th. The books are:

The Autobiography of Lincoln Steffens, 2 vols.

Charles W. Elliot, by Henry James, 2 vols.

America's Way Out, by Norman Thomas.

This New York of Mine, by Charles Towne.

Retrospect, by Arthur Balfour.

The Romance of Leonardo da Vinci, by Merejkowski.

The Story of San Michele, by Axel Munthe.

The Coast Guard have announced the following regulation concerning row boats:

Rowing boats whether under oars or sail shall have ready at hand a lantern showing a white light which shall be temporarily exhibited in sufficient time to prevent collision.

On Monday, July 13th, the Woods Hole Yacht Club held its second race of the season. The results were as follows:

Entries	Time
Baby Knock-Abouts	
"Porpoise"—Comstock Glaser	43' 9"
"Tyro"—Mrs. Crossley	43' 13"
"Scuttlebutt—Fred Copeland	43' 19"
"Adios"—Morris Frost	45' 28"
"Menidia"—Preston Copeland	49' 5"
"Charlog"—Ogden Woodruff	50' 18"
Dories	
"Aunt Addie"—Arthur Meigs	47'
"Dorine"—George Clowes	49'
"Hunky"—Kenneth Cole	51'
"Black Cat"—Vera Warbasse	53'
Catboats	
"Lurline"—Phillip Woolworth	44'
"Dinny"—Janet Blume	48'
"Salty Dog"—Tom Ratcliffe	50'
"Squido"—Henry Kidder	56'
"Lady Luck"—Mary Love	1:19

The Dories held a race, postponed from the previous week, on Tuesday, with the following results:

"Dorine"—George Clowes	1:10
"Black Cat"—Vera Warbasse	1:16
"Hunky"—Kenneth Cole	1:29
"Aunt Addie"—Arthur Meigs	disqualified

The handicap for the catboats has not yet been figured out. The results as stated above are how they crossed the finish line.

On Thursday, July 16, Mr. and Mrs. W. H. Woodford of Bridgeport, Connecticut, stopped at Woods Hole to have their houseboat overhauled at Hilton's. They are on a two months trip and have just come down from cruising along the Maine coast. Their passengers, a dog and two cats, were interested spectators of the overhauling process.

On Friday evening, July 17th, Mr. William W. Swan gave an illustrated lecture on "Yacht Racing" in the Woods Hole Golf Club under the auspices of the Quissett Yacht Club and the Woods Hole Yacht Club.

One of the Forbes' boats from Naushon was at Hilton's Shop on Monday, July 13th. The new motor boat, "The Dolphin," is to be used for swordfishing. She had a piece of cast iron in the keel for balance and was having the metal removed and wood substituted in the hope that the lighter weight would increase her speed.

Cape Cod is now busy driving mosquitoes from its territory. Last year, a three year project was started to rid the Cape of its summer pests and already a great deal of work has been done.

Salt water mosquitoes are the big problem of this region so work has been concentrated on the salt marshes. Seventy-five percent of the salt marsh breeding areas have now been ditched. To date 3000 gallons of fuel oil have been sprayed on both salt and fresh water breeding places. Up to June 20th, the total expenditure was $113,476.60 and fifty-two local men are on the payroll.

Mrs. Henry H. Fay is opening her estate "Nobska" for a garden party on Tuesday, July 21st, for the benefit of the Church Home Society for the care of children and young people. From three to six there will be bridge and Mah Jong, movies will be shown for the children, afternoon tea will be served and ice cream cones, lemonade and lollypops will be on sale. Admission to the grounds is twenty-five cents for adults and ten cents for children.

On Tuesday afternoon, July 21st at 2:30, The Tatterman Marionettes will pay a visit to the University Players Theatre at Silver Beach. They will present a special matinee performance of "The Glowing Bird," a folk fairy tale of old Russia.

(Continued on Page 112)

THE WOODS HOLE LOG

Continued from Page 110)

The University Players are showing the result of having worked together for the past few weeks. "Mr. Pim Passes By," this week's play, was consequently the most finished production they have put on this year, well cast, well acted and well staged. This does not mean necessarily that it was the most enjoyable performance of the season, for A. A. Milne has let his fancy run rampant and caused a terrific lot of pother about nothing. It was charming, as A. A. Milne always is, if you like that sort of thing.

Outstanding in the cast was Miss Elizabeth Fenner who has been with the Players since their very first production and is a favorite with her audiences. As Olivia Marden, she set the tone of the play. When that passer-by, Mr. Pim, very excellently acted by Charles E. Arnt, Jr., cast his thunderbolt of proof that Olivia's impossible first husband was still alive, it was Miss Fenner's superb restraint in acting that warned the audience not to take life too seriously. Throughout the play she managed to put across her meaning by the slightest lift of the eyebrow or shrug of the shoulder.

Miss Katherine Hastings, as Dinah, deserved special commendation also. On Monday it became evident that Miss Margaret Sullavan, who was to have played the part and who unfortunately was suffering from a strained back, would be unable to appear. Miss Hastings stepped in, ably filling the role even on such short notice.

Next week Miss Sullavan, who has just been starring on Broadway in "A Modern Virgin" will play the lead in "Coquette," the drama by Ann Preston Bridgers and George Abbott in which Helen Hayes played the title role in New York.

—M. S. G.

The Spencer Lens Company of Buffalo will hold an exhibit in the Old Lecture Hall from July 23rd to August 4th.

The Marine Experimental station of the Research Institute of the Lankenau Hospital, Philadelphia, has again opened for the season at North Truro, under the direction of Dr. Frederick S Hammett. The station stands on land granted by the Capt. L. D. Baker estate of Wellfleet Financial support is provided by a number of friends of the institution.

A student, who was asked to compose one verse of poetry including the words "analyze" and "anatomy," promptly produced the following:

My analyze over the ocean,
My analyze over the sea,
Oh, who will go over the ocean
And bring back my anatomy.

On Thursday evening, July 16th, the first Victrola concert of the season was presented in the M. B. L. Club House. Bilbert and Sullivan's comic opera, "Pinafore" was played and about a hundred members of the laboratory were present to enjoy the perennial favorite. The records were lent by Mr. R. C. McGoun, and whether it was because of the superior quality of the records or the fact that the phonograph has been repaired, at any rate the reproduction was excellent.

The second victrola concert of the season will be held at the M. B. L. Club House on Thursday, July 23rd. The program will be:

Mozart .... Kleine Nacht Musik
Brahms .... Symphony No. 4
Mozart .... German Dance

The program for the following week, July 30th is as follows:

Bach .... Prelude in E Flat
Bach .... Brandenburg Concerto No. 2
Beethoven .... Symphony No. 7

The Falmouth Publishing Company is publishing a weekly magazine to be distributed free of charge in hotels, tea rooms, drug stores and other public places, called "What's Fun in Falmouth." This is what the July 4th issue says about Woods Hole:

This village, four miles south of the shopping center of the town, besides being the terminal for the railroad and the steamers to Nantucket, Marthas Vineyard and New Bedford, is the home of famed scientific institutions;—the Marine Biological Laboratory; the U. S. Bureau of Fisheries station; and the new Woods Hole Oceanographic institution. A fascinating aquarium filled with colorful fish of the neighboring waters is at the U. S. Bureau of Fisheries, open to the public. Also at Woods Hole is Section Base 18 of the U. S. Coast Guard, with a fleet of 20 patrol boats for guarding ships at sea; and the U. S. Lighthouse Service depot and buoy yard. At Nobska Light, on the point, is a weather observatory and lighthouse, and here is obtained the most magnificent view in Falmouth, particularly at sunset, overlooking Vineyard sound, Buzzards Bay, Martha's Vineyard and the Elizabeth Islands.

On Monday, July 20th, the physiology class is having a picnic. They leave in the morning on the *Cayadetta* going by way of Robinson's Hole to Tarpaulin Cove for dinner.

On Tuesday the *Cayadetta* is taking the botany class to Black Rock.

Posts have been erected at either side of the drawbridge on Main street to support new gates which are to take the place of the wooden horses which now prevent traffic when the draw is open. The gates are due to arrive shortly.

THE COLLECTING NET

Vol. VI. No. 5. SATURDAY, JULY 25, 1931 Annual Subscription, $2.00
Single Copies, 25 Cts.

THE LIVING NUCLEUS AND EVIDENCE OF ITS DIRECT ACTION ON THE CYTOPLASM IN TISSUE CULTURES

DR. ROBERT CHAMBERS
Professor of Biology, Washington Square College, New York University

Before entering into a discussion on the action of the nucleus upon the cytoplasm, I wish to present a few observations on the effect of microdissecting nuclei in different types of cells. The nucleus of the fresh-water amoeba appears to have the consistency of a stiff jelly. One can stretch and tear it within the body of the amoeba and no ill effects are produced. The deformed nucleus is simply carried about by the normal streaming movements of the amoeba and an hour or so later may resume its original shape.

The nucleus of the Metazoan cells studied behaves quite differently. Nuclei of eggs, of connective tissue cells, of gut and gland epithelia, nerve cells, etc., are extremely susceptible to injury. When punctured, the nucleus of any one of these cells tends to collapse and to be converted into a coagulum. The membrane wrinkles and the nucleus diminishes in size (*Continued on Page 210*)

M. B. L. Calendar

MONDAY, JULY 27, 7:30 P. M.

Seminar. Dr. John P. Turner, "Fibrillar System in Euplotes."

Dr. Daniel Raffel, "Types of Variation produced by Conjugation in **Paramecium aurelia.**"

Dr. Ruth S. Lynch, "Effects of Conjugation in a Number of Clones of **Paramecium aurelia.**"

Dr. Tracey M. Sonneborn, "Crossing Diverse Clones of **Paramecium aurelia.**"

WEDNESDAY, JULY 29, 7:30 P.M.

Scientific Meeting. Under the auspices of the Society of Cellular Biology. Detailed program on page 127.

FRIDAY, JULY 31, 8 P.M.

Lecture. Dr. H. Spemann, professor of zoology, University of Freiberg, "Experiments on the Amphibian Egg."

THE IOWA LAKESIDE LABORATORY OPERATED UNDER THE AUSPICES OF THE STATE UNIVERSITY OF IOWA

DR. GEO. W. MARTIN
Director of the Laboratory, Professor of Agriculture, Washington and Jefferson College

The Iowa Lakeside Laboratory was founded in 1909 by Professor Thomas H. Macbride, at that time head of the Botany Department of the State University of Iowa, later President of the University, and now President Emeritus. For several years previous to that time Dr. Macbride and Professor Shimek had conducted summer field work in the Iowa lake country, and both felt that it would be desirable to have a permanent location. Since the University, as such, is prevented by law from establishing branches outside of Iowa City, it was necessary to secure private support, and a group of alumni organized, purchased land and buildings, and still hold the laboratory property, merely placing the facilities at the disposal of the graduate college and summer session of the university, under whose auspices it is operated.

The Iowa lake region is situated in northwestern Iowa near the western edge of the Wisconsin

TABLE OF CONTENTS

IOWA LAKESIDE LABORATORY

THE LABORATORY BUILDING ON WEST OKOBOJI LAKE

drift sheet, not far from the Minnesota birder, and owes its existence to the blocking of the original drainage systems at the time of the Wisconsin glaciation and the diversion of the drainage channels from the Mississippi to the Missouri River. There are three large lakes, Spirit Lake and East and West Okoboji Lakes. Spirit Lake is the largest and extends into Minnesota territory. West Okoboji Lake, upon the western shore of which the laboratory is situated, is next in size, being about six miles long and three miles wide, with an irregular shore line, and attains a depth of a hundred and forty feet, being by far the deepest of the group. East Okoboji, connected with it by a narrow opening, is long and narrow, and for the most part quite shallow. Scores of smaller bodies of water—lakes, ponds, and kettle holes—occur in the vicinity and afford a wide range of habitats for aquatic organisms. While many of these have been drained since the laboratory was founded, the multiplication of automobiles and the rapid develpment of giid roads have made many others easily available. Fortunately, drainage has ceased and it seems unlikely that it will be resumed on any extensive scale for many years to come, if at all.

The region about the laboratory was originally mostly prairie. It is now largely farmed, but extensive patches of prairie still remain. The lake shores and the valley of the Little Sioux River were for the most part forested and nearly all of this forest remains near the lakes, and much of it along the river. Numerous seeps and hanging bogs occur both in prairie and forest. The laboratory campus, of about a hundred acres, includes a small tract of mesophytic forest, a larger bit of xerophytic bur oak forest and prairie, hanging bog and marsh areas, surrounding a shallow bay rich in aquatic phanerogams and the associated animals and lower plants.

The laboratory building is merely a frame shelter for workers. It has recently been repaired so that it is adequate if not beautiful. It is supplied with running water and electricity, and a small amount of glassware and apparatus. Pending the erection of a fireproof structure, it has seemed advisable to ship needed supplies from the University for the summer only. There is a large headquarters cottage, with roomy, enclosed porch and public rooms, and a number of other buildings, including mess-hall, dormitories and small cottages. All are located on a wooded bluff, thirty to fifty feet above the level of the lake.

The laboratory is normally open for ten weeks, but in recent years arrangements have frequently been made for special work before and after the regular sesion. For purposes of instruction the session is divided into two terms of five weeks each, and one ciurse in botany and one in zoology are offered each term. These courses are open to both undergraduates and graduates, the accomplishment expected of the latter being, of ciurse, greater. Students register for but a single course at a time, hence there are no schedule complications The coarst work is very definitely directed toward meeting the needs of teachers of biology in the interior of the country, by emphasizing the availability for study of the familiar plants and animals of that region, many of which can be secured almost anywhere. There is, of course, no thought of disparaging the work of marine stations and all students who are not familiar with marine conditions are urged to make every effort to spend some time at Woods Hole or some other seaside laboratory.

Research material available is of necessity more limited than at a marine laboratory, but is sufficiently varied to supply a wide range of problems. As examples of the type of problems studied at the laboratory in recent years may be cited taxonomic studies on vascular plants, fish, Cladocera, rotifers, phyto-plankton, filamentous algae

THE LABORATORY

LOOKING WESTWARD ACROSS THE LAKE

and Myxomycetes; development studies on amphibians; studies on the temperature and oxygen changes in the lake; investigations of mycorhiza; the ecology of the prairie with reference to water relations.

The phytoplankton of the Okoboji region has been stated by competent observers to be one of the richest in the world, except for desmids, and the animal life of the lakes, while less completely known, is certainly rich and varied. Frogs and salamanders are abundant. Fish nests line the lake frontage of the laboratory.

Situated as it is in the tension zone between forest and prairie, the region in the vicinity of the laboratory offers many advantages for the study of ecological problems. Much has been accomplished, but much more remains to be done.

The resident staff this summer, in addition to the director, is composed of Professor H. S. Conrad, of Grinnell College, and Dr. Arthur P. Kelley, in botany, and Professor Ira T. Wilson, of Heidelberg College, in zoology. In addition to these men and their classes there are several research students carrying on investigations on the fungi and algae either independently or under supervision.

THE LIVING NUCLEUS.....ITS DIRECT ACTION ON THE CYTOPLASM IN TISSUE CULTURES

(Continued from Page 117)

possibly because of an escape of fluid. It has been claimed that the nucleus of the Amphibian red blood cell is an elastic body which, on stretching, will tend partially to return to the form it possessed before stretching. I am convinced that this property of elasticity appears only after the nucleus is dead and has become coagulated. When the nucleus within an intact red cell in blood serum is punctured, the nucleus swells appreciably and the haemoglobin-colored cytoplasm fades. Only then is the nucleus converted into a semi-elastic coagulum.

The nucleus of a plant cell such as that of onion bulb-scales is also highly reactive to puncture. Sometimes it disappears completely; at other times it collapses and then coagulates. When plasmolyzed plant cells are examined (e. g. onion cells plasmolyzed with potassium salts), the nucleus is often seen to be a swollen hyaline sphere. A puncture of such a nucleus causes it to disappear completely, the cytoplasm at the same time undergoing degeneration.

I shall not go into any detail here in discussing the considerable evidence thus far obtained in determining the alkalinity of the nucleus with respect to the cytoplasm surrounding it. Probably the first person who showed this is Paul Reiss of Strassburg. Reiss placed immature Echinoderm eggs between a cover slip and slide in sea-water colored with a pH indicator. On crushing the eggs, their nuclei took on the alkaline color of the indicator, while the cytoplasm assumed the acid color. I have repeated this experiment on starfish eggs with the same result. The first thing that one notices, after crushing, is the disappearance of the nucleolus and a change in volume of the nucleus. The nucleus shrinks and persists for some time as a hyaline nuclear remnant within the cytolizing debris of the cytoplasm. With phenol red in the sea-water the debris for a short time is bright yellow (acid), and the nuclear remnant is rose red (alkaline).

Evidence from carefully conducted micro-injection experiments have shown that the nucleus exhibits a distinctly alkaline reaction (a pH of about 7.6) while still within a healthy appearing, intact cell. It is interesting to note that, upon cytolysis, the cytoplasm becomes more acid than before (acid of injury). The nuclear remnant, on the other hand, maintains the same alkaline reaction possessed by the nucleus within the intact cell. It is for this reason that Reiss was able to note an appreciable difference in the reaction when the cells were crushed.

I wish to present here new evidence for the greater alkaline reaction of the nucleus in contrast to that of the cytoplasm. When neutral red is injected into the nucleus, the dye quickly passes out into the cytoplasm. On the other hand, when methyl red is introduced into the cytoplasm, the dye passes into the nucleus. Methyl red is the only indicator I have found which behaves in this way in the living cell.

The possible explanation is of interest in relation to the question of vital staining. Neutral red, in an aqueous medium on the alkaline side of pH 7.0, tends to be present in the form of its slightly soluble, undissociated free base. On the acid side of pH 7.0 it is far more soluble as a dissociated salt. The tendency is for the dye to pass from a medium in which it is less soluble to that in which it is more soluble. Probably this is what makes it an almost ideal vital stain, since physiological fluids which bathe cells are on the alkaline side of pH 7.0, while the internal protoplasm of the cells is on the acid side. Eggs in sea-water are readily stained with neutral red, almost too readily, for its tendency is progressively to accumulate in the cytoplasm until the eggs are overstained. When conditions are reversed, i. e., by acidifying the sea-water so that the latter is made distinctly more acid than the cytoplasm of the eggs, no staining occurs and colored eggs quickly become destained. When we study the distribution of neutral red between the nucleus and the cytoplasm of the egg we find that the dis-

tribution is such as can most easily be explained by the differences in their acid reactions, viz., neutral red in the cytoplasm never passes into the living nucleus and, conversely, when the dye is injected into the nucleus the dye rapidly diffuses out into the cytoplasm.

Methyl red is amphoteric and its basic properties are manifested only in a distinctly acid medium. At about pH 5 it tends to form a free base. In sea-water at the normal pH of 8.2 it exists almost entirely as the sodium salt of its acidic radical and as such is not a vital stain. In sea-water, acidified to a pH of 6 the methyl red readily diffuses into the cytoplasm and stains it. The eggs are viable at a still lower pH. The difference between this dye and neutral red is that the methyl red does not merely stain the cytoplasm but also diffuses into the nucleus. In methyl red and neutral red we have two dyes, one with a tendency to diffuse from a more alkaline medium and the other with a tendency in the reverse direction. Their behavior in regard to the nucleus and cytoplasm of the starfish egg is of the same order.

Puncturing the nucleus of the Metazoan cell produces an extraordinary effect. Owing to the plasticity and extensibility of the nuclear membrane the nucleus can be pinched almost in two with no dire results; but if the needle scratches the membrane so as to tear it, the nucleus breaks down and cytolysis occurs.

During this last Spring I have been working with Dr. Fell in Cambridge, England, on tissue-cultures under darkground illumination. The condenser we used was a recently improved special form with a wide angular aperture. It is constructed to permit the insertion of micro-needles beneath the hollow cone of light for operating upon cells in a hanging drop. The illumination is such that we were able to use oil immersion objectives, and to observe, in beautiful detail, the delicate cytoplasmic structures characteristic of tissue culture cells. On puncturing the nuclei of the cells we obtained a very beautiful darkfield picture of the changes which took place. The slightest puncture of the nucleus produces almost instantly a stoppage of all movement within the cell. This came out strikingly in the iris pigment cells in which the small pigment-rodlets scurry about in groups and singly, very much like guinea-pigs in a pen. The next thing one observes is the appearance, immediately around the collapsed and shrunken nuclear remnant, of very fine granules observable only with the darkfield. The granules progressively increase and the resulting opacity of the cytoplasm around the nucleus spreads until it invades the entire cell. Another change is in the mitochondria. This shows up beautifully in the fibroblasts, where long, sinuous mitochondria can be seen moving about in the cytoplasm. You can dig about in the cytoplasm with the needle and nothing happens; the mitochondria keep on moving and they maintain their long, sinuous shapes. But if the nucleus is punctured one notices, as the fine degeneration granules appear in the cytoplasm, that the mitochondria begin to be transformed into pale outlined spherules quite different from the highly refractive fat droplets which normally occur in relatively small numbers in these cells. The extended pseudopodia slowly lose their peripheral attachments and are withdrawn as the cell becomes converted into a shriveled, coagulated mass with regions here and there in which active Brownian movement can be seen. These progressive changes following the nuclear puncture occur generally within a period of five to eight minutes.

An extraordinary phenomenon occurs when one of the nuclei of a binucleate cell is punctured. Binucleate cells are frequently found in cultures of a variety of cells. They appear to be quite normal in all other respects. Those experimented upon were phagocytes, fibroblasts, gut and pigmented epithelial cells. With a very fine-tipped micro-needle one nucleus of a binucleate cell was slightly punctured. There occurred the same sequence of events as previously described, but in this case restricted to the immediate region of the injured nucleus, viz., an immediate cessation of movement, the gradual appearance of degeneration granules, the conversion of mitochondria into spherules and a retraction of the pseudopodia in the vicinity of the injured and shriveling nucleus. However, after a few minutes the degeneration granules began to fade from view, the mitochondrial spherules disappeared, normal mitochondria invaded this region, pseudopodia extended again, and the cell then appeared as a normal mononucleated cell, containing the shriveled remnant of the one nucleus which had been punctured. This is a striking demonstration to show that the presence of one healthy nucleus can overcome the degenerative action produced by the injury of the other nucleus. Recovery did not always occur. In several cases the degenerative effect of injuring one nucleus involved the other nucleus, which, in its turn, also degenerated, resulting in the death of the cell.

The essentialness of the nucleus to the continued life of a cell is, of course, undisputed. More directly it is well recognized that the elimination of a nucleus causes the cell from which it has been removed to lose the ability of reproducing itself. The evidence presented in this paper still more directly demonstrates the importance of the nucleus by showing that the presence of a healthy nucleus can keep a cell from destruction even after a certain degree of cytolysis has once set in.

We know nothing of the nature of the material which must emanate from the living nucleus to maintain or to restore normal conditions in the surriunding cytoplasm nor do we have an inkling of what escapes from a punctured nucleus to induce cytolysis. All that we know is the fact of the occurrence. Concerning the chemistry of

the living nucleus and cytoplasm the pronounced alkalinity of the nucleus in contrast to that of the cytoplasm is at present of no assistance in helping us to arrive at any conclusion.

DISCUSSION

Question: What conception do you have of the motility of the mitochondria? Do you get the impression that they are self-motile, or that they move by virtue of cytoplasmic currents?

Dr. Chambers: The sinuous movement of the long slender mitochondria in fibroblasts is at times much more active than at others. As far as I have been able to notice, the variation in their activity seems to correspond closely with the streaming movements of the cytoplasm of the cell. My impression is that the mitochondria are carried about passively.

Question: Have you formed any conceptions as to the time factor in death? Do you consider it instantaneous or is time involved? You have used the term *intra vitam*: might we use the term *intra mortem?*

Dr. Chambers: There are definite successive degenerative changes, none of which are necessarily mortal, because in the case of a binucleated cell you get all these visible changes, but the presence of the other nucleus may result in apparent complete recovery.

Question: What happens if you puncture the second nucleus?

Dr. Chambers: On puncturing the second nucleus the same degenerative changes occur, with death of the cell. I am speaking of the Metazoan nucleus; the Protozoan nucleus behaves quite differently.

Question: You said that if you cut off a piece of the fibroblast it continued normal for some time.

Dr. Chambers: Yes. That suggests that it is not the mere presence of the nucleus, but of something emanating from the injured nucleus which stops movement and results in degeneration of the cell.

Question: Does Brownian movement occur in the degeneration process?

Dr. Chambers: These degeneration particles show very active Brownian movement in some cases and not in others. When the cell is very much flattened the membrane apparently stiffens with death and the degeneration granules adhere to the inner surface so that no Brownian movement is appreciable.

Question: Have you been able to inject the nuclear contents of one cell into another?

Dr. Chambers: The difficulty lies in working fast enough. I have done so with the fluid contents of the germinal vesicle in the starfish egg. When removed and immediately injected into another egg I have obtained degenerative changes in the second egg but such material cannot be kept in a pipette more than a few seconds, after which the injected material will cause no cytolytic change.

Question: Do you get some degenerative stages from ordinary penetration of a needle into a cell?

Dr. Chambers: Ordinarily, when a sufficiently fine-tipped needle or pipette is used, no observable cytolytic change occurs. With blunt tipped needles it is very difficult to puncture many cells because of the extreme plasticity of the membrane of the cell and of its contents. With such instruments penetration is accomplished only with distinct disruption as the needle tears its way into the cell. Possibly the chief difficulty of many who attempt micro-manipulation of living cells, is due to their not appreciating the necessity of using the proper kind of micro-needles. That the mere penetration of a needle into a living cell produces some injurious reaction there is probably little doubt. In the starfish egg we have been able to demonstrate that an evanescent, injurious action does occur even when the operation is done so as to produce no appreciable morphological change. This has been shown by inserting a needle into an egg which previously had been colored blue by the injection of brom cresol purple. At the site of penetration a distinct minute trace of yellow occurs, indicating an acid of injury. Within a second, however, the color reverts to blue, indicating a neutralization of the acid. This reaction of acidity is more pronounced the more rapidly the needle is thrust into the egg.

In the case of tissue culture cells, the cytoplasm could be repeatedly punctured without producing any noticeable effect. It is only when the nucleus is punctured that cytolysis occurs.

GENETIC CONTINUITY OF THE CENTRAL BODIES

DR. ALFRED F. HUETTNER
Professor of Biology, Washington, College, New York University

The egg of *Drosophila melanogaster* is approximately one tenth of a millimeter in thickness and slightly less than half a millimeter long. It is centrolecithal, normally polyspermic and with the first polar body spindle in metaphase at the time of fertilization. Within ten minutes after the spermatozoa have entered the egg the second polar body is formed and the two pronuclei are ready to fuse. All early cleavages are simply divisions of nuclei within this large egg, and only at a much later stage are cell walls formed and still later the tissues differentiated.

The first cleavage results in two nuclei which are imbedded in clear and separate protoplasmic patches. These nucleated, separated protoplasmic islands are characteristic of the cleaving insect

egg. As far as the thirteenth cleavage all nuclear divisions with the exception of the primordial germ cells, are synchronous so that the same mitotic stage can be studied on hundreds and sometimes on thousands of nuclei in the same egg.

The Drosophila egg has to be punctured while it is immersed in the fixing fluid to insure rapid and proper fixation. However, when the puncture is very minute so that the fixing agent will enter slowly, the mitotic figures will be seen to vary from the point of puncture to the opposite parts of the egg. For instance, if one should puncture an egg in which the nuclei are all in metaphase, those nearest the puncture will be fixed in metaphase, but the further the figures are away, the later they are reached and arrested in their activity by the fixing agent, and the mitotic figures will show a gradation from metaphase into anaphase. One may therefore observe the centrioles actually elongate and divide and take up position at opposite sides of the interkinetic nucleus. One may also observe that the centrioles are dynamic, moving about and changing position in the protoplasmic islands as the cytomechanical processes are in progress.

I do not wish it to be understood that the central bodies as seen in the photographs, which were projected on the screen, conform precisely to the condition existing in the living egg. I would hold only that they are definite entities of some kind that conform to the principle of genetic continuity. It is possible, even probable, that in the coagulated cell they may have undergone material changes. Whatever their morphologic nature in the living cell, there seems to be no doubt that they are definitely organized parts of the animal cell which, at least in the more favorable cases in the animal and also in some of the lower plants, can be demonstrated to be continuous. In Drosophila the evidence indicates strongly that this continuity is perfect, since it seems that the spermatozoan carries the first centriole into the egg, and from this first one are derived every succeeding centriole, including those of the germ cells.

This leads to another aspect of this question since Dr. Fry has denied the existence of the centrioles in somatic mitoses in members of several phyla with a strong implication that they do not exist in any somatic mitosis. However, he does admit their existence in the maturation divisions of the oocyte and spermatocyte because in the latter they act as blepharoblasts. The photographs shown prove that in Drosophila the centrioles of the somatic mitoses are the same as those of the germ cells. Nor is it possible here to uphold that these definite bodies with their regular appearance, location and precise movement are random granules or staining artifacts or focal points of astral rays when no astral rays are present in interkinesis. I wish to emphasize that the photographs, which were submitted, are by no means exceptional or specially selected for their beauty. When photographing at such high powers one is definitely limited to one narrow focal plane and the best evidence cannot be photographed because parts of the picture may be slightly out of focus.

Since all the evidence gathered in Drosophila is in full accord with that worked out by Van Beneden, Boveri, Brauer, Flemming, Heidenain, Wilson, Griffin, McFarland, Mead, Coe and many others who worked on other phyla and in diversified classes of such phyla, it appears that Drosophila is by no means exceptional and represents merely the most complete and most evident history of the central bodies thus far observed.

REVIEW OF THE SEMINAR REPORT OF DR. HUETTNER

Dr. Henry S. Fry

Profoessor of Biology, Washington Squ are College, New York University

Dr. Huettner's description of central body behavior in cleaving Drosophila eggs is a most important contribution to the central body problem. In this species we are apparently dealing with a typical centriole which persists as an individualized structure from one cell division to the next. In this persistence, which is independent of the astral condition, lies the significance of the Drosophila material, and herein it differs from cleaving eggs of most species, where central bodies do not persist during the interkinetic period when asters are absent. The question therefore arises, is central body behavior in Drosophila different from that of many other forms, or will future study bring the phenomena under one category?

Obviously we are not dealing here with random granules; this point needs no further discussion. It also seems equally apparent that the central bodies are not just the coagulated focal area of astral rays, since they can be clearly demonstrated in fixed material when rays are absent, but this conclusion needs further examination. In this connection the results I am now obtaining in cleaving eggs of other forms (Pennaria, Cumingia, Chaetopterus, Asterias, Cerebratulus, and dogfish) may be significant for Drosophila. In them an orderly central body is present only when distinctly organized rays reach the astral center: in some species the rays must be coarse; in others, a few delicate rays are sufficient; in some cases a spindle without asters may have such bodies, provided the fibers are sharply focused. This body does not exist before the aster arises; it disappears simultaneously with the breakdown of the inner ends of rays, regardless of their clarity in the outer parts—hence such

bodies are not present in these species from late anaphase onwards. It is probable, therefore, that these bodies are actually nothing but the coagulation product of the area where the rays come to a focus, an area which differs chemically and physically from the surrounding region where there is more or less inter-ray material. These bodies may be large and diffuse as in Echinoderms, or minute and period-like as in Cerebratulus and Chaetopterus.

May the central bodies of Drosophila also be only the coagulation product of the focal area of rays? Dr. Huettner presented two arguments that apparently disprove this possibility: first, central bodies can be demonstrated during mitosis whether the rays of the living aster are fixed or not; second, they persist during the interkinetic period when asters are absent. These facts, however, cannot be accepted as conclusive until certain points have been cleared up which make the study of central bodies in Drosophila peculiarly difficult.

Fixation of Drosophila eggs is unusually precarious and undependable. It is well known among cytologists that in the eggs of most species a given type of fixation at a given mitotic phase in a certain stage of development usually yields results that are repeatable; for example, variations in the structure of asters, under such conditions, among different eggs of the same female or of different females, are negligible. Furthermore, the use of a proper reagent reveals dependably on the fixed slide the gross condition of the living aster, i. e., large or small, distinct or faint. Drosophila eggs, however, present a very different situation. As Dr. Huettner stated, they are so impervious to reagents that each one must be pricked individually to permit entrance of the fluid. The results in different eggs at the same stage are quite variable, due probably to differences in the size of the puncture with consequent differences in the amount of fluid entering the egg and the speed diffusion. Not only are such differences apparent between different eggs fixed at the same stage, but in some they exist at different distances from the point of pricking, as pointed out by Professor Wilson in his recent lecture. For example, the lantern slides of anaphase figures showed clear rays in some cases, whereas others, in identically the same stage, as indicated by the position of the chromosomes, showed no rays at all. All astral stages exhibit variability of ray fixation. A given mitotic stage, which undoubtedly has rays in the living condition, may or may not show them after coagulation. It is at least possible that ray material may be coagulated more readily at the aster's focal region where it is more abundant than elsewhere where there is inter-ray material. Were such the case, it is possible that under one condition of fixation both the focal area (central body) and the peripheral portion are fixed, the latter showing clear rays; whereas under a slightly different condition of fixation, although the center is coagulated as previously, the rest is left non-radial, even though both figures were radial in the living condition.

It would have added important information to the discussion if Dr. Huettner had given some information concerning the fixatives used—whether more than one reagent was employed, and if so whether or not there are variations in the coagulation products. Until fixation of Drosophila eggs can be made so dependable that the mitotic figures at a given stage fix in a similar manner and adequately preserve the gross living condition, conclusions concerning the presence or absence of central bodies in relation to the presence or absence of rays are necessarily uncertain.

The second difficulty lies in the unusual shortness of the interkinetic period when asters are absent. In most species twenty to thirty minutes elapse from one metaphase to another, and the interkinetic period is about eight to ten minutes. In Drosophila from metaphase to metaphase requires only about eight minutes and the interkinetic period covers at most two minutes. Such a brief period might be overlooked if certain classes of cells are regarded as well fixed and others, put up at the same stage under similar conditions, are dismissed as poorly fixed.

I recently studied forty Drosophila eggs (fixed by a formol-alcohol-acetic mixture) having reformed nuclei, and showing no asters. Less than half of the eggs showed central bodies; whether or not these eggs actually had asters in life which were not preserved by the fixation is unknown. The important point is that more than half had no central bodies. Two of the latter, photographed with ultra-violet light by Dr. F. F. Lucas of the Bell Telephone Laboratories, showed no central bodies. The evidence from these very preliminary studies is of course not conclusive, but it raises the possibility that in the very brief interkinetic period central bodies may actually be absent. Assuming that the presence of central bodies is related somehow to the presence of rays, it would be easy to pass from the latest telophase stage having rays in the living condition to the earliest prophase stage having rays, unconsciously skipping the brief interkinetic period. The whole situation is further aggravated by the vagaries of fixation, since the rays may or may not be fixed.

All Drosophila eggs fixed with a given reagent at a given interkinetic period and treated in the same manner, as far as technique permits, should be reported. If the great majority show central bodies at all stages, including the interkinetic period, that is one result; if, however, as I found in the sample of forty eggs mentioned above, a large percentage does not show central bodies, at least the percentage of each class should be reported. If certain groups are dismissed as non-significant, the reason for such action should be made clear, in view of the brevity of the interkinetic period

and the uncertainties of fixation. Possibly Dr. Huettner has considered all this, but no information was given on this point.

Unfortunately, space forbids discussion of the division of the central body during metaphase. In some of the forms I am now studying this occurs also, and is associated with the widening of the spindle-end which renders the aster bifocal. Whether the body is a dynamic center playing some role in effecting these changes, or whether the centriole's change from a single to a double condition is a passive result of the unifocal astral area becoming bifocal due to the widening of the spindle-end, remains to be proved.

Should further study show the central bodies of Drosophila actually to be absent during the interkinetic period, this would be in harmony with the condition during maturation of Drosophila eggs, where there are no asters and no central bodies. It would also harmonize with the results in the other forms previously noted, where orderly bodies are absent during interkinesis when asters are absent. If, on the other hand, further study confirms the conclusion that we are dealing with typical centrioles, then it must be ascertained whether or not the behavior of Drosophila centrioles is in a different category from that of the other forms mentioned. In this connection it may be noted that the centriole-blepharoplasts of sperm-forming cells show diverse behavior: in some species arising in late spermatogonia; in others, in the primary spermatocytes; in yet others, in the spermatids. If such variability of this structure is manifest during spermatogenesis in different species, may not central bodies show diverse behavior during cleavage?

Dr. Huettner's study is a stimulating contribution to the subject, which will call forth further research and contribute to the eventual solution of this important cytological problem.

PHOTO-ELECTRIC CELL RECORDS OF ANIMAL LUMINESCENCE

DR. E. NEWTON HARVEY

Professor of Physiology, Princeton University

Determination of the absolute intensity of weak luminescence is a difficult undertaking, since the quality of the light is far different from that of a comparison source. Relative intensities of luminescences may be determined by various types of photometers, provided the light lasts long enough to make an eye comparison. For rapid flashes of luminescence such as those of many luminous organisms some sort of recording mechanism becomes absolutely necessary. The photocell with amplification and a string galvanometer is a convenient means of recording such flashes of light.

The pioneer work in analysing luminescences was carried out by Dr. W. R. Amberson who studied the decay of luminescence when solutions of luciferin and luciferase, the light-giving substance of animals, are mixed in a test tube. His method of recording was to revolve photographic film on a kymograph drum past a narrow slit in the blackened test tube in which the solutions were mixed. After development, light intensity could be measured in terms of the blackening of the film. These decay curves were logarithmic, the slope (velocity constant) proportional to luciferase concentration, varying with luciferin concentration, increasing 2 to 3 times for a 10° rise in temperature and independent of stirring the solutions. The time for decay was absent about 8 seconds.

The photo-electric recording method allows very rapid decays to be measured in which the time for half decay is of the order of ½ to 1 second. Even such short flashes of luminescence behave in the same manner as the longer ones studied by Amberson, giving logarithmic decay curves. A long series of records of velocity constants shows that with constant luciferase concentration these are inversely proportional to the square root of the concentration of luciferin plus oxyluciferin, its oxidation product. This can be explained by assuming the velocity constant as measured by luminescence to depend on the luciferin plus oxyluciferin adsorbed on luciferase, the luciferin and the oxyluciferin having the same adsorption isotherm.

A long series of studies of the flash of the fire-fly obtained by Mr. P. A. Snell in different oxygen concentrations show that the normal reflex flash in the male is perfectly symmetrical and looks like a normal distribution curve. The duration is about ⅙ second at room temperature. Brown and King find the female to give an unsymmetrical flash with a secondary maximum.

The West Indian elaterid beetle, Pyrophorus, gives a long lasting luminescence on stimulation. This rises to a maximum in 0.8 to 1 second and remains there with rhythmic 5% changes in light intensity, having a period of 0.2 to 0.3 second, which gradually becomes longer and finally merges into a rhythmic pulsation of light of about 1 second period, detectable by the eye. These are ascribed to rhythmic volleys of impulses sent out from the nerve ganglions controlling the light organ.

Rapidly changing intensities of luminescence in a suspension of luminous bacteria can be recorded: for example, the flash of "excess luminescence" which appears when these bacteria are deprived of oxygen. The intensity of this flash is

about twice that of the normal light. It falls off rapidly in intensity and lasts some 12 seconds. These records have not been published but were illustrated by lantern slides. The method will prove as valuable in the analysis of luminescence as the optical lever in muscle physiology.

Literature

Amberson, W. R., Jour. Gen. Physiol. 4, 517, 1922.
Stevens, K. P., Jour. Gen. Physiol. 10, 859, 1927.
Harvey, E. N. and Snell, P. H., Jour. Gen. Physiol. 14, 529, 1931.
Snell, P. A., Science, 73, 372, 1931.
Brown, D. E. S. and King, C. V., Physiol. Jool. 4, 207, 1931.

REVIEW OF THE SEMINAR REPORT OF DR. HARVEY

DR. WILLIAM R. AMBERSON
Professor of Physiology, University of Tennessee

The application of the photo-electric cell to the study of animal luminescence registers another success for the use of modern physical apparatus in biological research. The results described by Dr. Harvey present us with a very accurate picture of the time relations of these rapidly changing luminescences. Although it is true that I was able, some years ago, to discern the main relationships now confirmed in the present study, as Dr. Harvey has kindly indicated, it is also true that my old method was exceedingly laborious, and relatively inaccurate, in comparison with the quick and easy study now made possible. The new method represents an important technical advance which may now be extended to other problems in this field.

THE CARBON DIOXIDE COMBINING POWER OF MAMMALIAN MUSCLE

DR. LAURENCE IRVING
Associate Professor of Physiology, University of Toronto

Although muscle contains only about half as much CO_2 as blood in each gram, the total reserves of muscle CO_2 in the body are about five times greater. This quantity of reserve CO_2 is subject to alteration by changes in the CO_2 tension of circulating blood. The relation between CO_2 content and tension may also be used to represent the condition of the acid-base equilibrium and the buffering power. But it is much more difficult to deal with an active and sensitive solid tissue like muscle than with the fluid and relatively stable blood.

The two variable factors to be determined are (1) CO_2 content and (2) CO_2 tension. The first may be accurately determined by a method developed from Van Slyke's principles of blood analysis. There is no direct method for determining CO_2 tension in a living solid tissue. But it is evident that the CO_2 tension of a tissue must always be greater than that of the venous blood in order to maintain the escape of CO_2 as it is produced The circulation of mammalian muscle is so elaborate and the diffusion of CO_2 is so easy that Krogh has figured that the difference in tension between muscle and its venous blood cannot be perceptible. The sampling of venous blood from a muscle and subsequent analysis of it in the quantity available have required the development of special operative and analytical technique.

The gastrocnemii of spinal dogs were dissected so that the only blood passing out through the popliteal veins came from the gastrocnemii alone. Blood samples were then drawn from one vein for the determination of CO_2 tension, and the muscle was removed for analysis. These two results showed the CO_2 content of the muscle at about a normal CO_2 tension. The dogs were then either overventilated to reduce the CO_2 tension or ventilated with a CO_2 rich mixture to raise the CO_2 tension. After this treatment had become effective, blood samples were drawn from the second muscle and the muscle itself was analyzed.

When the results are plotted as CO_2 content against tension, there is a definite trend that resembles the curve for blood, but at a lower level of CO_2 content. The most suitable curve will be one which fits the points ranging from $P\,CO_2$ (20 to 200 mm. Hg), is reproducible, and shows the derivatives in reasonable form. One expression for such a curve is CO_2 in cc. per 100 grams is equal to $3.4 \sqrt{P\,CO_2}$.

The curve summarizing the data can be modified to show the amount of combined CO_2. This requires the assumption of a value for the absorption coefficient of CO_2 in muscle. The value selected is $k38^\circ$ is equal to 0.41, representing the dissolved CO_2 as if it were that which would be dissolved in the water of the muscle. The curve is most useful when applied to the estimation of hydrogen ion concentration, and in this form the pH calculated at $P\,CO_2$ is equal to 50 mm. is near 7.0, and at 200 mm. near 6.6.

The slope of the combining power curve may also be used to estimate the buffering power of muscle. The figures show that the carbonates of muscle are only about ¼ as effective as the other buffers. Further, the buffering due to CO_2 escape is about as large as that of the other buffers beside CO_2. It also appears that the muscle buffers are nearly as effective as those of blood, in spite of the lower CO_2 capacity.

The analytical results are quite satisfactory in agreement, but the constants used in determining the acid-base equilibrium are only reasonable as-

sumptions. But allowing for their subsequent modification to give more correct absolute values, it is clear that the carbonate system in muscle can be compared in general character with any carbonate system, and can be used for the derivation of the condition of the acid-base equilibrium.

REVIEW OF THE SEMINAR REPORT OF DR. IRVING

Dr. Walter S. Root

Assistant Professor of Physiology, School of Medicine, Syracuse University

The report of Dr. Irving is an interesting contribution to our knowledge of the acid-base equilibrium in living tissue. Unlike similar studies upon other tissues, gaseous equilibrium was attained in vivo.

The use of the carbon dioxide tension of the venous blood as the carbon dioxide of muscle probably gives values lower than those actually present. The studies of J. A. Campbell upon tissue gas tensions seem to indicate that carbon dioxide diffuses from the tissues under a perceptible head of pressure.

The shape of the carbon dioxide dissociation curve of mammalian muscle and the pH values calculated from this are similar to the results obtained by Fenn, Stella, and Brody upon frog tissues. All investigators agree that the carbon dioxide capacity of muscle is less than that of the blood. Apparently the carbonates of frog muscle are more effective compared with the other buffers present than is the case in mammalian muscle.

Fiske and Subbarow have demonstrated the presence of a substance in mammalian muscle which the Egglestons have called "phosphagen." Recently Meyerhof and Lipmann, working with frog muscle, have shown that in the presence of carbon dioxide "phosphagen" splits yielding base. It is probable that the absence of a complete plateau in the carbon dioxide dissociation curve is due to this reaction..

SOME OBSERVATIONS ON SELF-STERILITY IN STYELA

Dr. H. H. Plough

Professor of Biology, Amherst College

Genetic self-sterility is the inability of sperm to fertilize eggs of the same individual even though both sorts of gametes are capable of fertilization as shown by crosses. Although common among plants, such a condition has been demonstrated with certainty in animals only in the Tunicate, Ciona. This was first shown by Castle, and the situation has been investigated by Morgan over a long period of years. Conklin long ago suggested that the common sea-squirt, *Styela partita*, showed self-sterility, and I have demonstrated this fact for a number of years to the Embryology students here at Woods Hole. Last summer I attempted to analyse the situation in this species in detail and the results disclose an interesting situation, especially by comparison with Ciona. in the latter, self-sterility is complete and has been supposed by Morgan to be genetically determined. In addition, the physiological nature of the block to self-fertility has been considered My data bear on both these problems in Styela.

With Styela it is impossible to excise the gonads or ducts in such a way as to get eggs free of possible contamination by sperm. I therefore set up the experiments in such a way as to make use of eggs which had been exposed to an even suspension of their own sperm before being crossed. Single animals were allowed to shed eggs and sperm normally in separate fingerbowls of sea-water. From each, a thick sperm suspension was withdrawn with a fine pipette, and the eggs and remaining sperm stirred. Equal samples of from 100 to 200 eggs were then picked up and placed in 10 cc. of fresh sea-water, in as many Syracuse dishes as there were crosses to be made. The sperm suspensions were then diluted and equal amounts used in making every possible cross fertilization. The success of the self or cross fertilizations was shown by the number of tadpoles in the dishes on the following morning.

A number of such crosses showed quite clearly that in Styela, self-fertile, partially self-sterile, and completely self-sterile individuals exist side by side. Duplicate tests indicated that the results were self-consistent when egg samples of this size were taken, and the same sperm suspension used. Fuchs, working with Ciona, reported an increase in the percentage of fertilization with a more concentrated sperm suspension, thus raising the question as to whether samples taken at different times might be expected to give consistent results. My tests on this point are not conclusive as yet, because of the difficulty of getting animals to shed more than once. A small number of animals which shed on four different occasions gave counts which were somewhat variable in the actual percentage of fertilization from one test to another, but the relation of self and cross-fertility remained constant in every case. It appears, therefore, that the self and cross fertility shown by one series of adequate tests is in general a consistent index of certain inherent differences in the animals themselves.

This conclusion is made much stronger by ex-

periments involving a large number of crosses simultaneously. One such series shows all reciprocal crosses between nine different individuals. The percentages of fertilization show all possible steps from complete self-sterility to complete self-fertility, with quite marked variability in the cross-fertility from one individual to another. In general, the lower the percentage of self-fertility, the greater is the number of sperm suspensions which increase the fertility of the eggs in crosses. The most striking fact which such a series of tests shows, however, is that there is a negative correlation between the fertility of eggs by sperm of other individuals, and the ability of the sperm of the same individual to produce increased fertility in other eggs. Stated more simply this means that self-sterile individuals shed sperm which are less likely to give increased fertility in crosses than partially self-sterile individuals, and the latter than self-fertile individuals. Such a relation is in no sense inherent in the data, and can be accounted for only by the inherent, or genetic nature of the animals themselves.

The simplest genetic hypothesis which appears to fit the facts described is that certain individuals carry a mutant gene S, for self-sterility, which is allelomorphic to the normal F, for self-fertility. SS individuals are self-sterile, and will not fertilize any animal bearing S genes. SF animals may show partial self-sterility. Such an hypothesis may be tested by rearing one generation of hybrids, as I hope to do in the future. The genetic determination of self-sterility in Styela thus appears to be far simpler than that in Ciona, where all animals are self-sterile, and for which a complex multiple factor situation has been suggested by Morgan. It may be that Styela shows how the Ciona situation has originated.

A few words may be added with respect to the physiological nature of the block to self-fertilization. In Ciona, Morgan believed that the test cells or their secretions within the membrane prevented sperms of similar genetic constitution from reaching the egg. This seemed justified by his observation that removal of the membrane mechanically made self-fertilization possible. I have already reported that fertilization of Styela eggs in sea water with a few drops of weak NH_4OH or $NaOH$ (pH 8.5-8.7) made all sperm suspensions of approximately equal fertilizing power. By similar treatment Loeb long ago brought about species cross fertilization, and Tennent family cross fertilization in Echinoderms. In such experiments it has been supposed that the change in the pH of the sea-water produced an effect on the egg cortex. If this is the correct explanation then we must look at the egg cortex as furnishing the block to self-fertilization rather than the egg membrane or its inclusions.

REVIEWS OF SCIENTIFIC BOOKS

The Use of the Microscope. By John Belling (Cytologist, Carnegie Institution of Washington) McGraw-Hill Book Company, New York, 1930.

This excellent treatise, written by a skilled cytologist and microscopist, is one that should be in the hands of everyone who makes use of the microscope, whether in research or in teaching. It is written with commendable brevity and absence of needless technicality, and in the course of its twenty-four short chapters deals with almost every aspect of microscopical research in biology. To the reviewer its strongest point seems to be the numerous practical suggestions, evidently the product of long personal experience in the laboratory, with which its pages are everywhere crowded. It is difficult to select specific examples of this, since it is characteristic of all the chapters; but especial mention may be made of those dealing with the routine microscope, illumination, light filters and screens, the condenser, the cover-glass problem, photography, testing and care of the microscope, and rules for high-power microscopy. The work contains also chapters on the past and future of the microscope, its literature, discoveries due to its use, and practical exercises, including brief directions for cytological work. Novel features are a list of "practical points" at the end of each chapter and a final list of two hundred "questions" for a searching of the souls of those addicted to the practice of microscopic research. A useful glossary, literature list and index are appended. The book is cordially recommended. —E. B. Wilson.

Invertebrate Zoology. Harley. Jones. Van Cleave. 1931. xiv-282 pp. McGraw-Hill Book Company.

In writing and revising this textbook of invertebrate zoology the author has successfully avoided the mistake of writing for the sake of impressing his colleagues in the field. In the revision, stress has been taken from the taxonomic organization originally employed, while general material has been introduced such as was formerly found in textbooks of general zoology. The index reveals one brief reference to the entoderm; the ectoderm is referred to the same page while the mesoderm has a paragraph on the following page. Nematocysts are called exclusively "nettling" cells; cnidoblasts are not mentioned; neither for that matter is the coelom given a place in the index although it is mentioned at different places in the text. The echinoderms are discussed between the Molluscoidea and the Mollusca, and one finds scarcely a hint of the possibility of constructing a diphyletic organization of the animal kingdom. This text must have been found useful, otherwise a second edition would not have been called for, and a hasty survey indicates that the revised book is an improvement. —W. C. Allee.

The Collecting Net

A weekly publication devoted to the scientific wcrk at Woods Hole.

WOODS HOLE, MASS.

Ware Cattell .... Editor

Assistant Editors

Margaret S. Griffin   Mary Eleanor Brown

Annaleida S. Cattell

THE BEACH QUESTION

One of the property owners on the Bayshore beach has objected to our editorial note in which we said that their action in blocking off a portion of the beach was not courteous. Nothing has taken place to change our opinion. Furthermore, we believe that most of the people in Woods Hole agree with us. In appropriating the northern section of the beach for private use each property owner is assigning himself about sixty-five feet of the beach. Together they have left somewhat less than half of the beach for the rest of the people in Woods Hole. If all of Woods Hole contained only five more families the beach would be equitably divided. One day last week there were three hundred people on one side of the barrier and only one individual on the other. This arrangement is not a democratic one, and some change ought to be made to relieve the crowded conditions that have prevailed since the erection of the fence.

BOOKS AND OUR SCHOLARSHIP FUND

We have received recently as a gift from *The Scientific Monthly* a large number of books which are now on sale for the benefit of THE COLLECTING NET Scholarship Fund. A substantial discount has been made from the publishers list price, because we wish to sell as many as we can during the summer. The books are of many kinds. Some of them are technical books in the various fields of science, but most of them are more general in character. Everyone will find books that are of especial interest, and a cordial welcome is extended to members of the scientific institutions in Woods Hole to examine them. Our office on Main Street is always open and we hope that investigators and students will avail themselves of this opportunity. They are welcome at any time, but we expect most of our visitors in the evening when our typewriters have ceased their noisy chatter.

THE NOMINATION OF TRUSTEES

Following out the suggestions contained in the preliminary report of the special committee of the Corporation of the Marine Biological Laboratory (printed in THE COLLECTING NET for July 18, 1931), the following memorandum has recently been distributed to the members of the Corporation:

At the annual meeting of the Corporation of the Marine Biological Laboratory held on August 12, 1930, a special committee was appointed to work out a representative method of making nominations for officers and trustees to be elected by the Corporation at the annual meeting in August. The report of this Committee was printed during the fall of 1930 and a copy was sent to each member of the Corporation.

Although the provisions of this report cannot be approved and adopted prior to the annual meeting in August, one of them—viz. that concerning suggestions and recommendations from the Corporation at large for nominations of Officers and Trustees of the appropriate class, to be sent to the Chairman of the Nominating Committee,—was sanctioned by the Executive Committee as not inconsistent with the present practice. The opportunity is given herewith to carry it out.

Officers and Trustees are elected by the Corporation; members of the Corporation are elected only by the Trustees. The new officers—viz. Treasurer and the Clerk of the Corporation, are elected annually.—Trustees are elected for a term of four years. The present officers and Trustees of the Class of 1931, any one or all of whom may be reelected, are as follows:

1. Treasurer of the Corporation Lawrason Riggs, Jr.
2. Clerk of the Corporation........Gary N. Calkins

8 Trustees of the Class of 1931

3. H. C. Bumpus	7. W. J. V. Osterhout
4. W. C. Curtis	8. J. R. Schramn
5. B. M. Duggar	9. William M. Wheeler
6. George T. Moore	10. Lorande L. Woodruff

If you wish to make suggestions for nominations, please fill in the blank below and mail prior to July 31 to the Chairman of the Nominating Committee for 1931, Dr. A. C. Redfield, Marine Biological Laboratory, Woods Hole, Mass.

Gary N. Calkins,
Clerk of the Corporation.

SUGGESTIONS FOR THE NOMINATING COMMITTEE 1931

N. B. The numbers below correspond with those given in the list above. Nominees must be members of the Corporation.

1. For Treasurer........ 2. For Clerk............

For Trustees of the Class of 1935

3.	7. ....
4.	8. ....
5.	9. ....
6.	10. ....

Signature..............................

ITEMS OF INTEREST

On Thursday evening, July 23, Mrs. C. E. McClung gave a picnic to the Woods Hole members of the zoology department of the University of Pennsylvania and their families. The party was scheduled to be held at Sippiwissett, but rain interfered and Mrs. McClung entertained in her apartment.

Dr. L. O. Howard, who recently received the Capper Award, consisting of $5,000.00 and a gold medal, sailed on the S. S. Virginia on July 11 for Honolulu via the Panama Canal. He will stop over a few weeks in Honolulu, after which he will sail for Paris by the way of the Indian Ocean and the Mediterranean.

Miss Agnes Addison, the daughter of Dr. and Mrs. W. H. F. Addison is correspondent for *The Falmouth Enterprise* during her trip through Europe.

Dr. David I. Hitchcock from the department of physiology of the Yale University School of Medicine is coming to the laboratory on the first of August. He and his family will occupy the Budington cottage on Orchard Street, Crow Hill.

M. B. L. Calendar

WEDNESDAY, JULY 29, 7:30 P.M.

Seminar. Dr. B. Lucke, "The Mechanism of Bacteriotropin Action."
Dr. M. H. Jacobs and Dr. A. K. Parpart, "Is the Permeability of the Erthrocyte to Water Decreased by Narcotics?"

Dr. L. V. Heilbrunn, "The Action of the Common Cations on the Protoplasmic Viscosity of Amoeba."

Dr. R. Chambers, "The Formation of Ice Crystals in the Protoplasm of Various Cells."

A variety of research apparatus including some devices of entirely new design are now being exhibited by Mr. J. H. Emerson of Cambridge in the Old Lecture Hall.

Miss Evelyn Howard, who has just received her doctor's degree from the University of Pennsylvania, has been appointed assistant in physiology at the Johns Hopkins Medical School.

Dr. Selman A. Waksman gave an address on marine biology at the staff meeting of the Oceanographic Institution held on Thursday, July 23.

The Spencer Lens Company opened their annual exhibit at Woods Hole in the Old Lecture Hall on July 23rd. They are showing a number of new instruments, pre-eminent among which are two new research microscopes in which are incorporated several original and improved features. They are exhibiting a binocular microscope with adjustable inclined eye-pieces. The two new types of fine adjustments for microscopes are being displayed as well as a new Delineascope for color slides as used by Mr. Craske in his lecture last Thursday evening. Mr. C. H. Ash of the Boston office and Mr. L. M. Potter from the Buffalo headquarters are in charge of the exhibit, and will be here until August 4th.

APPLICATION FOR MEMBERSHIP IN THE CORPORATION OF THE MARINE BIOLOGICAL LABORATORY

At the annual meeting of the Board of Trustees of the Marine Biological Laboratory on August 11 new members will be elected to the Corporation of the laboratory. "Professional biologists and persons who have rendered conspicuous service to the Marine Biological Laboratory, may upon written application to the Clerk of the Corporation and upon recommendation of the Nominating Committee be elected by the Trustees to membership in the Corporation." Applications for membership in the Corporation must be endorsed by two members of the Corporation. Forms on which to make formal application may be obtained from the business office of the laboratory.

At their meeting last August the Trustees elected the following persons to membership in the Corporation:

Dr. D. W. Bronk, Dr. Edouard Chatton, Dr. A. B. Dawson, Dr. L. C. Dunn, Dr. Helen M Miller, Dr. A. W. Pollister, Dr. Danial Raffel, Dr. W. S. Root, Dr. T. M. Sonneborn, Dr. Margaret Sumwalt.

MT. DESERT ISLAND BIOLOGICAL LABORATORY

Dr. Samuel O. Mast gave a lecture on July 14th at the Maine Marine Station, LaMoine, Maine. His subject was "Function of the Eye Spots in Unicellular Forms."

The third seminar of the season will be given by Dr. Mast on Monday evening, July 27th, at the Dining Hall.

Dr. E. M. East of the Bussey Institution visited the Laboratory on Monday, July 20th.

Dr. Esther F. Byrnes arrived at the Laboratory July 17th to continue her researches. Dr. Byrnes is accompanied by her sister.

The Fourth Popular Lecture will be given by Dr. E. K. Marshall, Jr., on Thursday afternoon, July 30th.

The young people of the Laboratory gave the first dance of the season at the Grange Hall on Saturday night, July 18th, in honor of the older people. Music was imported from Bar Harbor and refreshments from Leslie Dunton's, in Salisbury Cove.

Miss Kitty Marshall entertained the young people of the Laboratory at supper on Sunday, July 19th. —LOUISE R. MAST.

ITEMS OF INTEREST

Mr. Seymour M. Farber, who was awarded one of The Collecting Net scholarships of $100.00 for work at the laboratory this season, plans to begin work at the Marine Biological Laboratory early in August.

Dr. Henry W. Scherp, a student in the physiology course this summer, has been appointed assistant at the Rockefeller Institute for Medical Research. He will go to New York about September 1.

The S. S. Olympic recently reported that the "Atlants" was 530 miles west of Plymouth, England.

Dr.E. J. Lund, professor of physiology at the University of Texas, and Mrs. Lund, have arrived in Woods Hole for the rest of the summer. They have taken one of the laboratory apartments.

Miss Elizabeth Ross Shaw of Winthrop, Massachusetts, who has been biological prooof-reader for the Boston office of Ginn and Company, spent a few days this week in Woods Hole. She expects to return to Woods Hole next year to do some work in marine biology and microscopy.

On Sunday, July 26th, Gilbert and Sullivan's operetta, "The Pirates of Penzance," will be given in the M. B. L. Club at 8 P. M. Librettos of the opera will be for sale at $.25 apiece.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the hole turns to run from Buzzards Bay to Vineyard Sound:

Date	A. M.	P. M.
July 25	1:16	1:25
July 26	2:19	2:27
July 27	3:07	3:16
July 28	4:01	4:06
July 29	4:47	4:54
July 30	5:30	5:41
July 31	6:09	6:23
Aug. 1	6:51	7:09
Aug. 2	7:35	7:51
Aug. 3	8:13	8:34
Aug. 4	8:59	9:21

In each case the current changes approximately six hours later and runs from the Sound to the Bay. It must be remembered that the schedule printed above is dependent upon the wind. Prolonged winds sometimes cause the turning of the current to occur a half an hour earlier or later than the times given above.

SCRIPPS INSTITUTION OF OCEANOGRAPHY

Mr. E. H. Quayle has returned to this institution after spending three weeks on a collecting trip in the Chiricahua Mountains of South Eastern Arizona. This trip was organized and financed by Mr. Joseph Sefton and the party obtained large numbers of specimens for the San Diego Society of Natural History. Since his return Mr. Quayle announces that he has received from Arthur Wrigley, London, England eighty specimens of European corals for comparison with those of Southern California which are being studied by him.

Mr. A. E. Longley, botanist in the U. S. Department of Agriculture, is making his residence at this institution for several months while he is engaged in special investigations at the U. S. Department of Agriculture Acclimatization Station near Torrey Pines.

Mr. H. R. Byers of Massachusetts Institute of Technology and Mr. G. B. Armstrong of Pomona Collge are serving as Graduate Assistants in Meteorology under Dr. G. F. McEwen for the summer.

The following dates for elctures at the Institution have been arranged and others will be announced as soon as possible. Evening lectures will be popular or semipopular in character while afternoon lectures will tend to be more technical. All persons interested are cordially invited to attend either.

Evening Lectures. (8 p. m.)

Monday, July 20: "The Meaning aud Causes of Cancer" Dr. Leo Loeb.

Friday, July 24: "Japanese Gardens" (Illustrated by Colored Lantern Slides). Director T. Wayland Vaughan.

Monday, July 27: "Depths of Penetration of Light in Sea Water in its Relation to Distribution of Organisms." Dr. Burt Richardson.

Afternoon Lectures. (4 p. m.)

Friday, July 17: "The Buffer Mechanism of Sea Water." Dr. E. G. Moberg, Dr. D. M. Greenberg, and Miss E. Allen.

Friday, July 24: "Five Recent Papers on Evaporation." Dr. Burt Richardson.

Friday, July 31: "Notes on Recent and Current Oceanographic Activities." Director T. Wayland Vaughan.

THE WOODS HOLE LOG

The Southern Massachusetts Yacht Racing Association held its second annual meeting on Friday, July 17, in the reading room of the Woods Hole Oceanographic Institution. Delegates were in attendance from the yacht clubs at Nantucket, Edgartown, Vineyard Haven, Wianno, Waquoit Bay, Quissett, New Bedford, Mattapoisett, Ducksbury and Marion.

Vice-commodore Frank J. Frost and Edward A. Norman, chairman of the race committee, represented the Woods Hole Yacht Club. A committee reported considerable progress on the development of uniform classes among the member yacht clubs, with a view to permitting inter-club racing.

A three-day cruise to include the Edgartown Regatta on August 1 was planned, and a number of matters of routine business were transacted.

The new officers elected are: president, H. Nelson Emmons, Beverly Yacht Club at Marion; vice president, C. Gardener Aikin, New Bedford Yacht Club; secretary, L. W. Sargent, Edgartown Yacht Club; and treasurer, Franklin King, Quisset Yacht Club.

Before the meeting, the delegates attended a luncheon at the Breakwater Hotel and were addressed by Gardner Emmons of the Oceanographic Institution in the work and plans of that institution.

The results of the races of the Woods Hole Yacht Club on Monday, July 20th, were as follows:

Baby Knock-Abouts

"Adios"—Morris Frost	59 min. 25 sec.
"Porpoise"—C. Glaser	1 hr. 2 min. 40 sec.
"Tyro"—Mrs. Crossley	1 hr. 2 min. 45 sec.
"Charleg"—Ogden Woodruff	1 hr. 2 min. 50 sec.
"Scuttlebutt"—P. Copeland	1 hr. 14 min. 05 sec
"Menidia"—Fred Copeland	1 hr. 14 min. 10 sec.

Dories

"Dorine"—George Clowes	60 min. 15 sec.
"Aunt Addie"—A. Meigs	1 hr. 3 min. 30 sec.
"Hunky"—Kenneth Cole	1 hr. 18 min.

Catboats

"Lurline"—Philip Woolworth	59 min. 55 sec.
"Dinny"—Janet Blume	1 hr. 21 min.
"Squido"—Marjorie Kidder	1 hr. 27 min.
"Lady Luck"—Mary Love	1 hr. 31 min.

The handicap for the catboats is still undecided and the time given is consequently how they crossed the finish line.

Application blanks for permission to drive out-of-state cars may be obtained from THE COLLECTING NET office.

A serious accident occurred on Wednesday, July 22nd, when two cars crashed on the main road just below Nobska Road. Mr. William Hemenway of the Carpenter Shop was driving his own truck towards Woods Hole and Mr. Lawrason Riggs III, son of the treasurer of the M. B. L. driving a Chrysler, was going towards Falmouth. Mr. Hemmenway's car skidded on the wet pavement, the two cars crashed, the truck being jammed against the brick wall. Mr. Hemmenway was thrown from his car and badly cut and bruised. He was taken directly to the doctor's in Falmouth where twelve stitches had to be taken on his forehead. According to latest reports, he is doing as well as can be expected. Mr. Hemmenway's car was so badly damaged that it had to be towed. Mr. Riggs was not injured.

The stage at Silver Beach this week was the scene of a stirring emotional drama of youth in a small Southern town. We had a confidential tip as we entered from one of the members of the company that Peggy Sullavan's fine acting had wrung tears from the Players' group who were the audience at dress rehearsal; and even with so much to anticipate, we were not disappointed.

"Coquette," by Ann Preston Bridgers and George Abbott is emotional; it is heavy tragedy effectively contrasted with a bright, Southern society first act and farcical comedy in certain of the minor characters. For the sake of comparison we wish we had seen Helen Hayes as Norma on Broadway. We do not hesitate, however, to commend Miss Sullavan very highly. The role is a difficult one., demanding great versatility in acting. As the flirtatious Southern belle whose love for one outside her Social pale brings ruin to her father, her lover, and herself, she was at one moment utterly charming and trivial and the next, she reached the depths of real emotion with her interpretation. A native Virginian, she, too, was most perfect in her Southern accent.

The entire cast was thoroughly satisfactory although not all of the accents would convince a true Southerner. Kent Smith as the father was particularly fine. Also, we have been hoping for the opportunity of seeing Henry Fonda play a leading role ever since his successful acting of the comparatively minor part in "Paris Bound," and so we welcomed him in the part of the lover. Mary Lee Logan in her first role of the season also deserves praise for her able acting of the girl in her awkward 'teens.

The Players did a difficult play surpassingly well, and it is with interest that we are looking forward to the production of the light French comedy, "Her Cardboard Lover," which is scheduled for next week. —M. S. G.

THE WOODS HOLE LOG

At 7:26 on the evening of Tuesday, the twenty-first, the fire siren sounded and all the cars in Woods Hole turned out to follow the fire engine. After a mad dash around Crow Hill and the Gansett section, the fire engine came to a halt, the chief's car from Falmouth drove up, the parade of cars stopped and as the crowd thronged around, the Chief was heard to ask where the fire was. The reply came from the hook and ladder, "We don't know; we're trying to find it." Another wild rush for cars and the procession circled around some more and out on the point. There the fire had been, in the oil stove in a room adjoining the garage on Mrs. T. H. West's place. Though the fire was small and the damage slight, the chase was as exciting as if the conflagration had been terrific.

The rockets seen from the M. B. L. Club on Saturday the eighteenth were sent up by a Coast Guard boat that had become disabled near Gay Head. It drifted as far as the Woods Hole end of Naushon, where it was carried by the tide towards Vineyard Haven. Before it had gone very far one of its sister ships towed it back to the Base.

On Thursday, July 16th, the Boston auxiliary schooner, the Olive M. Williams, ran aground early in the morning. She was discovered by two Coast Guard boats; a line was made fast to the mainmast, another line attached to the side and by hard pulling the vessel was finally dislodged at 7:30 in the evening.

Reports had been current that the boat was a rum runner, but upon investigation it was found that instead of being loaded with liquor, she bore a heavy cargo of ice, having discharged her boatload of fish in New Bedford. She is owned by Tibbetts fisheries in Boston and carried a crew of seven men.

The A. & P. Stores send over to Nantucket eight tons of sugar every Wednesday to supply the eight stores on the island. On July 22nd the supply would have been ruined had the sudden downpour in the morning occurred a few minutes earlier. As it was the rain held off until the sugar was safely loaded on the steamer.

The results of the races of the Woods Hole Yacht Club on Monday, July 20th, were as follows:

On Thursday, July 23rd, Leonard Craske, sculptor and artist, gave a lecture in the auditorium of the Laboratory on "The Art and Uses of Color Phitography." The lecture was illustrated.

The U. S. S. Constitution "Old Ironsides" will make New Bedford her port from July 31st to August 6th. The city is planning a series of entertainments for a gala reception to the old frigate. Friday, the day of arrival, is reception day; Sunday, an old time ship service will be held in the Seamen's Church; Monday, there will be a clambake for officers and crew of the ship, followed by a sightseeing trip and a dinner for the officers; Tuesday is the gala day when all New Bedford is expected to turn out in a street parade; Wednesday, whaleboat races; and Thursday, "Old Ironsides" departs.

The Church Work Association of the Church of the Messiah holds weekly meetings every Thursday afternoon in the parish house. Summer residents are cordially invited to attend.

Mrs. R. S. Thayer and family of Lancaster have taken the Sargent Cottage on Nobska Road for the summer.

Mr. and Mrs. West and family from Philadelphia have taken Mrs Frank Handy's house on Buzzards Bay Avenue for the summer.

On Friday, July 31st, the Walter Main Circus will put on a show in Falmouth for one day only.

The board of Governors of the Woods Hole Yacht Club has called the Annual Meeting for Saturday, August 8th, at 8:15 P. M. at the Club Station.

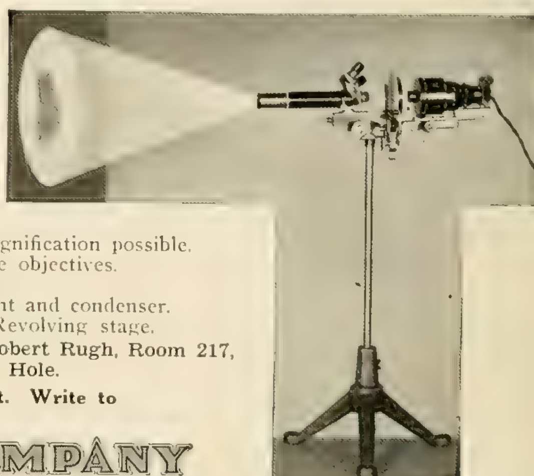
On Wednesday afternoon, July 22nd, the Methodist Episcopal Church held its annual sale of flowers, aprons, home-cooked food, candy and ice cream in the vestry of the Church.

TIDE TABLE AT BREAKWATER BEACH

At the following hours (Daylight Saving Time) it is high water at the Breakwater Beach:

Date	A. M.	P. M.
July 25	5:04	5:22
July 26	6:03	6:13
July 27	6:54	7:10
July 28	7:47	7:54
July 29	8:30	8:40
July 30	9:16	9:26
July 31	9:54	10:03
Aug. 1	10:39	10:48
Aug. 2	11:13	11:30
Aug. 3	11:59	..
Aug. 4	12:11	12:40

Approximately six hours later, the tide is low.



THE COLLECTING NET

Vol. VI. No. 6. SATURDAY, AUGUST 1, 1931 Annual Subscription, $2.00 Single Copies, 25 Cts.

A SCIENTIST'S IMPRESSIONS OF THE PROGRESS OF EDUCATION AND SCIENCE IN RUSSIA

DR. SELMAN A. WAKSMAN

Professor of Microbiology, Rutgers University

It is very difficult in a brief space to give any fair idea of the nature and extent of the experiments which are being carried out at present in Russia and which are, no doubt, bound to prove of the greatest consequence in history. These experiments are a result of a revolution, not only political but social, economic and intellectual in nature; they affect every phase of human life. In order to understand the full significance of the Russian Revolution, it is not sufficient merely to describe certain observations or to draw certain conclusions, for any conclusions are bound to be superficial, unless one is able to compare conditions in Soviet Russia, not with those in Western Europe and in America, but with those in Russia before the Revolution. I shall attempt to limit myself here only to the conditions under which the student and professor live (*Continued on Page* 149)

M. B. L. Calendar

TUESDAY, AUGUST 4, 7:30 P.M.

Seminar. Dr. Eugene F. DuBois, "Surface Temperature and the radiation of Heat from the Human Body."

Dr. Pierre Rijlant, "Oscillographic Study of the Cardiac Ganglion of Limulus Polyphemus."

Dr. D. M. Whitaker, "The Change in Rate of Oxygen Consumption at Fertilization of the Eggs of Chaetopterus, Cummingia, Nereis, Arbacia and Fucus."

Dr. R. W. Gerard, "Phosphocreatin in Nerve in Relation to Activity."

FRIDAY, AUGUST 7, 8 P.M.

Lecture. The Reynold A. Spaeth Memorial Lecture. Dr. R. G. Harrison, professor of comparative anatomy, Osborn Zoological Laboratory, Yale University.

THE DESERT LABORATORY OF THE CARNEGIE INSTITUTION OF WASHINGTON

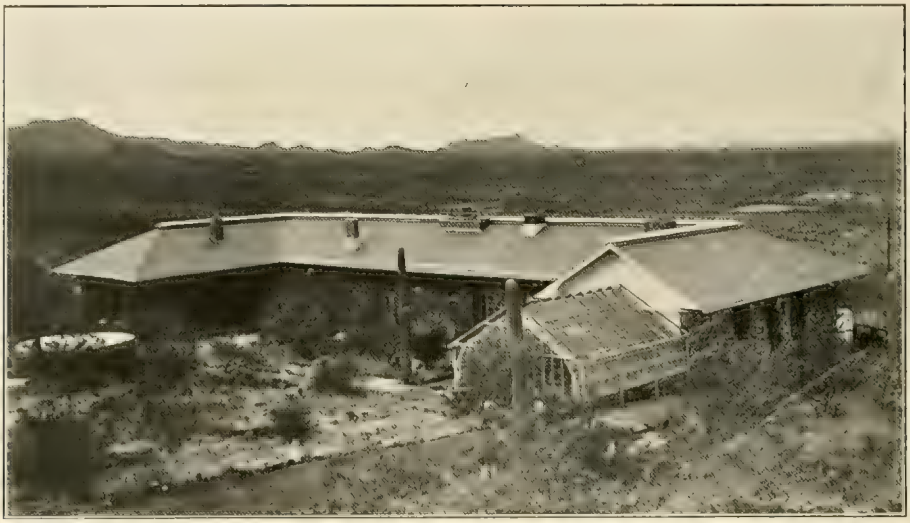
DR. FORREST SHREVE

Director of the Laboratory

The word "desert" commonly brings to mind a picture of vast expanses of drifting sand almost wholly devoid of plant and animal life. Areas of this character may be found in the Sahara and the Desert of Gobi, but they are the most extreme manifestations of the desert. The arid and semi-arid regions comprise nearly one third of the land surface of the earth and they exhibit contrasts and variety to even a greater extent than do the forested portions of the earth. The deserts of the United States and Mexico are of the less extreme type, for the most part, supporting vegetation and animal life of surprising abundance.

The definition of "desert" is not simple. Like a good species it can be delimited only on the basis of a group of characteristics. Deficiency of rainfall is the most important, but an amount of precipitation found in a desert at low latitudes will support forests

TABLE OF CONTENTS



THE DESERT LABORATORY OF THE CARNEGIE INSTITUTION OF WASHINGTON

at higher latitudes. High temperatures are prevalent in deserts, but extremely low ones also occur. Each of the great desert regions of the world has its own group of climatic conditions. They have many features in common, notably rainfall which is insufficient in amount or irregular in distribution, great range of daily temperatures, low relative humidity, high total wind movement, and high percentage of sunshine. As a direct or indirect result of these characteristics the streams of the desert are intermittent, the soils are highly charged with soluble salts and are poor in organic matter, the surface of the soil is gravelly or stony, and erosion by water and wind is active. The vegetation of the desert is composed of a relatively small number of dominant plants; their stature is low and communities which they form are sparse and open. It is customary to regard the plants of the desert as highly specialized, but the structures and activities which fit them for a successful existence in the desert are no more unusual than those found in the plants of rain-forest, salt marsh or pond, albeit they are familiar to a small number of biologists.

The Desert Laboratory of the Carnegie Institution of Washington is located in one of the richest and most diversified desert areas in North America, at Tucson, Arizona, within 65 miles of the Mexican border. The laboratory buildings are situated two miles from Tucson in the midst of a tract of 840 acres of virgin desert at an altitude of 2,663 feet. The laboratory grounds have been protected from grazing and trespass for twenty-four years, and afford a variety of types of surface, soil and vegetation for observation, collecting, and instrumental or experimental work. Desert plains extend from Tucson to lower and higher altitudes, and several mountain ranges are accessible which reach 8,000 to 9,000 ft., as well as numerous hills and small mountain ranges of varied mineralogical composition.

The rainfall at Tucson, chiefly in midwinter and midsummer, averages 10.5 inches for the year. The winters are variable in temperature, but minima of 25° F. are usually registered from two or three to 10 or 15 times. The summers are warm, with the daily maximum sometimes above 100° for 20 or 30 days in succession, but the temperature rarely rises above 108°. The low atmospheric humidity does much to counterbalance the high temperatures, as far as human comfort is concerned.

Tucson is a very ancient town, with Indian, Mexican and American traditions, and a population of 40,000 persons, in which these elements are rather equally mixed. Its location on the main line of the Southern Pacific Railway and on the Borderland Highway gives easy access to it from the East and the West. Tucson is the seat of the University of Arizona, the Arizona Experiment Station, the Southwestern Forest and Range Experiment Station of the U. S. Forest Service, the Magnetic Station of the U. S. Coast and Geodetic Survey, and of the Desert Sanatorium and Research Institute of Southern Arizona. Important work is also maintained there by the U. S. Biological Survey. These organizations bring together a group of over 80 persons interested in various phases of biological work in its scientific and practical aspects.

The Desert Laboratory is open throughout the year. At present there are four resident investigators, and every year there are generally four or five visiting investigators who remain from two or three months to a year. No lectures or courses are given, and there is no way in which university credit can be secured for work done there. The facilities of the laboratory are open to accredited investigators who make application three months in advance, and present plans for their work on which approval of their prospective residence can be based. Preference is given to those whose work is most closely related to the current investigations of the laboratory staff. The number of persons that can be accommodated is dependent on the character of their work and needs. Those whose work is chiefly in the field can almost invariably be accommodated and given a table.

There are no living or dining facilities at the Desert Laboratory, but houses or rooms can easily be secured in Tucson. From the office of the laboratory a regular bus line is operated to the business district. The long distances which are involved in living arrangements, field work or contacts with other institutions lead most of the investigators to purchase cars, thereby saving much time and energy. Excellent stores make it unnecessary for the visitor to bring with him anything but the most unusual items needed.

The equipment includes two stone laboratory buildings with 12 rooms, a small frame laboratory, a shop, a greenhouse, a number of lath and screen shelters, and a "cave" with nearly constant temperature conditions. All of the appliances and supplies commonly needed in morphological and physiological work are on hand, but unusual pieces of equipment are secured only when needed in a particular investigation. A small library is maintained with files of the principal botanical, physiological and ecological journals, as well as those of general scientific interest. There is also a small collection of texts, handbooks, reference works, floras and books relating to the desert regions of the world.

The work of the Desert Laboratory centers around the ecology and physiology of desert plants with the chief emphasis on their water relations. The importance of water to the living organism, vital as it is throughout nature, assumes a new emphasis when those parts of the world's surface are considered in which it is so scarce. Its importance in connection with growth, respiration, photosynthesis, movements and other physiological phenomena becomes more critical. The availability of water to the plant is seen to affect its germination, its success in giving new individuals a start in life, its distributional movements, its genetical behavior, its response to pathogenic organisms, its intricate relations with insects and other animal life, and the whole trend of evolutionary development. The flora of the southwestern states and of northwestern Mexico comprises a very high percentage of plants restricted to that region, a considerable number of genera not found elsewhere, and even some six families of plants which have come about in this relatively small area. The great majority of plants confined to the desert region are so intricately adjusted to its conditions that they have not spread into adjacent, more moist, regions,

VEGETATION IN THE VICINITY OF THE LABORATORY

and none of them, except certain tropical cacti, have become spontaneous weeds in other places. The consideration of the desert flora not only emphasizes the deep-seated influence of the scarcity of water, but also indicates that Arizona, Sonora and the adjacent regions have been desert for a very long time.

Broadly conceived biological work must keep in view the larger procession of nature, and the complex relations between the various groups of organisms and the multifarious physical conditions, as well as the intimate physiological processes of the individual organism. An effort to understand the life of the desert, like that of the ocean, is an extremely complex task. William Keith Brooks used to say to his students, "My hand is related to everything in the universe." In studying the life of desert or ocean it becomes obvious that no feature of them is without potential influence upon the particular problem that is being investigated.

Two of the most striking features of the vegetation in the Tucson region are the gradual changes encountered in climbing any of the larger mountains, and the abrupt changes that will be noted in going from one type of soil to another on the floor of the desert. The mountains present a panorama of plant life extending from the cacti, diminutive trees and thorny shrubs of the desert, through the region of yuccas and century plants, the open groves of evergreen oaks, and the forests of yellow pine, to the heavy stands of spruce, Douglas fir and aspen. The desert displays a simple pattern of vegetation in which a relatively small number of species form a still smaller number of communities, each distinctive and each occupying areas of different physiographic history and different soil characteristics.

Some of the earlier work of the laboratory was concerned with the mountain panorama and the relation existing between the vertical distribution of the vegetation and the gradients of conditions. At present, attention is being given to the desert floor, the distribution of some of its commonest plants, and the investigation of the conditions which appear to be concerned in the limitation of these plants to certain habitats. The perennial plants of the Tucson region fall into two groups which are very sharply marked. These are the succulent plants, represented almost solely by the cacti, and the non-succulents, represented by plants of a wide range of relationships. There are a number of very marked differences between these groups, not only in their structure and anatomy, but in their relation to environment and in their physiological behavior. The cactus is shallow-rooted, presents a transpiring surface which is very small with respect to its volume, thereby reducing its chlorophyll-bearing surface as well, and by every feature which conserves water also retarding the gas exchanges between its tissues and the atmosphere. Through its capacity for the rapid and considerable storage of water, it is enabled to meet its needs by utilization of the moisture that is available in the surface levels of the soil for a very brief time after every rain. The non-succulent plants have not the uniformity of structure and behavior of the cacti, but they are alike in their dependence on the more deep-seated water of the soil. They differ among themselves in the extent of their leaf surface, in the seasonal duration of their foliage, in the location of their chlorophyll-bearing tissues, as well as in the character of their root systems. Experience has shown the great plasticity of these plants with respect to water supply. Many of them are able to live for weeks in a soil which has fallen below the moisture content that is theoretically presumed to cause wilting, at the same time that they are exposed to hot dry air which is in almost constant motion. Under such conditions all growth is in abeyance, many leaves fall and even twigs and branches may die. The water content of the leaves and stems falls to a low level, and the plant is in a state of dormancy which in many ways resembles that of a seed, except that there is the small but inevitable loss of water day by day. On the other hand, if an abundant and constant supply of water is given to one of these hardy plants, it will grow rapidly, soon exceed its normal size, present a larger leaf surface and produce vastly greater crops of seed. It must, however, have a well drained soil, with favorable conditions for oxygen supply to the roots.

One of the commonest plants in southern Arizona is the creosote bush, which ranges from southern Nevada to central Mexico, growing in extensive pure stands in some of the most unfavorable parts of this great desert domain. As a plant which has successfully solved the difficulties of a low and uncertain water supply and a soil highly charged with salts or impregnated with calcareous hardpan, the creosote bush is calculated to elicit the admiration of the plant student. Much of the work at the Desert Laboratory is concentrated at the present time in an attack on the ecological and physiological behavior of this evergreen bush. While the cactus is drawing water from its succulent tissues for its current needs, the creosote bush, like all of its non-succulent fellows, is making a struggle each day to maintain a balance between its water income and its water expenditure. The progress that is being made in this work leads to the hope that some of its results may serve as a key to a better understanding of the non-succulent plants in general. The sap of the foliage of the creosote bush has, much of the time, a very high osmotic value as compared with that of other plants. An extended study is being made of the differences in the osmotic value of the sap of plants in different habitats, favorable

and unfavorable, and this work is being carried through several seasons, coupled with an investigation of the moisture and salt content of the soil in which the bushes are growing. At the same time an investigation is under way that will betray the manner in which the shrub handles its water, the course of the daily fluctuations of water in stem and leaf, and the influence of experimental conditions on the ability of the plant to maintain its water solvency.

Another plant of the desert which is under observation and investigation is the ocotillo, a large member of a very small family, which Dr. W. T. Hornaday aptly described as looking like a "bunch of loosely held wands." Its branches have little green color, and beneath their bark is a horn-like layer which serves as insulation against loss of water. The leaves appear shortly after every rainy period, and are thin, soft and well provided with stomata. A few days after the soil begins to dry out at a depth of 15 cm., the leaves turn yellow and fall. If it rains again, two weeks later there will be another crop of leaves, perhaps there will be a dozen crops of them in a year. When it is in leaf the ocotillo uses large quantities of water and is in fact a moist-country plant. When the leaves fall it becomes an ideal desert plant. Several pieces of work have been done on the ocotillo at the Desert Laboratory, notably on its transpiration and stomatal movements. Work now under way is furnishing a much more precise basis for our understanding of the habits of both phases in the life of this plant.

As a background for all of the investigations on plants, continuous records are being kept of the principal climatic and environmental conditions. The importance of the seasonal distribution of rainfall and its effects on the great reservoir of water in the soil has led to detailed instrumentation in these fields. In addition to an electric recording rain gage in the laboratory garden, there is a series of thirty six gages in different parts of the laboratory grounds, sixteen of them arranged in a 300-meter square for the determination of the local variability of the rainfall and eight of them at 100-meter intervals on the slopes of Tumamoc Hill, for the recording of vertical differences in each shower. In addition, two lines of long-period gages extend west and southwest from Tucson, to Yuma and the Gulf of California, by which semi-annual readings are secured from these very arid and thinly settled regions. A percolimeter is in operation for the measurement of the run-off and penetration in each shower, and fortnightly readings of soil moisture are taken at eight depths to two meters, and occasionally to four meters. The temperature of the soil is also being followed at depths of one and two meters in connection with this work. Records have been taken over long periods of the temperature of the air and soil, humidity, evaporation, wind and sunshine, as well as many records designed to show in what manner and degree the conditions in certain habitats differ from the climatic conditions of the region.

Records are being kept of the fluctuations in plant life as well as in the climatic conditions. Several small areas on the laboratory grounds were carefully charted in 1906, and are permanently marked so as to make possible for many years a study of the changes taking place. Other areas on several types of soil are used for a census of the short-lived plants which appear after the summer and winter rainy periods. Areas are also under observation on which the creosote bushes have been charted, and the rate and manner of reproduction and establishment are being followed from year to year. On some of these areas the old bushes have been removed, and various modifications of the natural surface have been made, as by raking, spading, or covering with soil, with a view to shedding light on the very poor natural reproduction of this plant. Soil cultures of the creosote bush are also being carried on, with soils differing in texture and in the amounts of calcium, these being designed to give data on comparative growth, and also to supply material for a study of their water behavior under the different soil conditions.

Visitors who are seriously interested in the work of the Desert Laboratory are always welcome. The time given to them is amply repaid by the fact that they are able thereafter to visualize much better the work that is going on, and are able to read more understandingly the publications from the laboratory. Those who are interested in the work, but who are unable to see it in person, should apply for copies of the annual report, reprinted from the Yearbook of the Carnegie Institution, for an illustrated booklet on the laboratory, or for such separates of journal articles as may be available for distribution.

A SCIENTIST'S IMPRESSIONS OF THE PROGRESS OF EDUCATION AND SCIENCE IN RUSSIA

(Continued from Page 145)

and work in Soviet Russia. On the portals of the First University of Moscow, the oldest university of Russia, there is written the following motto: *Nauka Trudiastchimsia,* or "Knowledge for Those that Labor." The university which, less than fifteen years ago, admitted only the very rich, with very few exceptions, and where a laboring man or a peasant had little chance indeed of ever being admitted, unless special circumstances favored him, has now a *sine qua non* requirement

for admission that the candidate be one who labors, with his hands or with his brains. This motto can serve as a device for the whole Russian situation at the present time.

Following the World War and the Revolution, many Russian scientists left their country and went to seek a home on other shores. This, as well as the fact that numerous new institutions of higher learning have been opened, accounts for the great shortage of professors and scientists in Soviet Russia, as a result of which one professor usually occupies more than one position. A well known physiologist enumerated to me seven positions which he holds and to which he has to devote a certain amount of his time. In most cases these duties are limited to attending conferences once a week or once a month. However, he has to supervise the work of several assistants in at least four institutions, each of which would well require the service of his full time.

The younger generation of scientists has not arrived yet, at least not in sufficient numbers. This is due largely to the ravages of the War, the Revolution and the Famine, which led not only to a direct destruction of many promising youths, but also to the crippling of the institutions of higher learning, for a few years. However, one encounters everywhere enthusiastic groups of young men and young women, recently graduated from the universities, eager for knowledge and for new ideas and willing to sacrifice all material comfort for an opportunity to devote their life to scientific work.

The term University or *Polytechnicum* has disappeared from the Russian vocabulary and has been replaced by the term *Vuz*, which designates merely an institution of higher learning. To be admitted to one of these now numerous institutions one must be a graduate of a gymnasium, with a seven-year course, only little less vigorous in its training than formerly, or of a technical school, with a five year course, or of a *rabfak*, or workers' faculty, with a three or four year course. The latter is especially interesting, because this type of school originated since the Revolution. It is an attempt to give workers and peasants a preparatory education, in concentrated form, enabling them to enter a *vuz* as soon as possible. There are now in Russia nearly one hundred such schools or workers' faculties with about 50,000 students; while few of the students in the other two types of schools, especially in the first, receive stipends, practically all of the students in the latter school receive stipends of forty rubles* per month. This is about sufficient to cover the cost of books, clothing and living expenses.

When a worker is taken from the factory and is sent to the *rabfak* or to the *vuz* he is given the full wage during his entire course of study which he was earning at that time at the factory. He is encouraged in every way possible to continue his training and education. Probably two-thirds or more of all the students in the *vuzes* hold stipends, these ranging from forty rubles per month and up to two hundred rubles per month during the last one or two years of training. Out of this the student has to pay for his meals and books. He usually obtains a free room in one of the dormitories and pays a nominally low price for his meals. This enables him to devote himself entirely to his studies. When he graduates from the *vuz*, there is no difficulty in obtaining a position. As a matter of fact, in many instances, especially in the case of engineers, he has already been engaged by some factory a year or so before he graduates. If he wants to continue further training, in order to devote himself to research work or to teaching, opportunity is given either at the same institution or at one of the numerous investigational institutions.

It is interesting to note that most of the men usually take up technical courses, engineering and agronomy courses, while the women go into medicine, nursing and biology.

The courses of study in the higher institutions are highly specialized; the students in agriculture receive, for example, a three-year course in practical subjects with only a glimpse into the fundamentals; the students in engineering receive a five-year course in some specialized branch. The more brilliant students, however, can be left for another three years as candidates, then receiving a salary of two hundred rubles a month and specializing in one particular branch of science; these students or candidates may later qualify as professors.

As to the professor himself, his salary and living conditions are favorable when compared with those of the members of the working class, peasantry and intellectuals. His salary ranges from 300 to 1200 rubles per month, depending on the number of positions that he holds and their nature. He has also larger and more convenient living quarters, and is allowed a three-months vacation instead of the ordinary two to four weeks. As long as he keeps away from political activities, if he is not a communist, and devotes himself to his duties as investigator or teacher, he is not only left alone but even variously encouraged. The director of the institution is usually a worker appointed by the government, but he interferes very little with the research activities of the faculty, as long as the members do not indulge in underground political activities. It is interesting to note that the student body has something to say concerning the election of the professors and the nature of the courses to be given. Strikingly enough, it is this body that usually insists that the courses be made stiffer and the students be held more to their tasks. If a professor is discharged, for one reason or another, the great-

* An equivalent of twenty dollars.

est punishment usually consists in sending him out of Leningrad or Moscow to a corresponding chair in a provincial university.

The scientific institutes are very well equipped with apparatus and supplies. They have been completely reorganized since the Revolution and are actively supported, especially those institutes which deal with natural sciences, industry and agriculture. Some of them would do honor to any country in Western Europe or America, especially those dealing with biological, chemical and soil studies.

Considerable emphasis has been placed recently in the newspapers on the fact that Russian scientists are requested to keep in close touch with the practical and applied. This is, to a certain extent, correct. There are, however, two justifications for this tendency. With the large numbers of growing industries and with the rapid development of scientific agriculture in a large rural country, in which ninety per cent of the population was illiterate only a dozen years ago, it is quite natural that emphasis should be laid upon practical problems. There is a tremendous need in Russia for practically trained men and women; numerous new problems arise daily which require immediate solution. Where are these problems to be solved and where are the men to be trained if not at these institutions? Further, the Russian scientist has frequently been accused of lacking direct contact with the practical and of tending to be too theoretical. For a poor country, with great daily needs, this is too much of a luxury, unless certain returns to the practical can be made.

There is no doubt that the engineer, chemist and agronomist receive primary consideration and are accordingly free in their expressions as well. The scientist, and especially the economist, philosopher and historian, are more limited in opportunities and in freedom of expression. However, with all the forces driving toward the practical, there is still considerable evidence of opportunities for research in various fields. This is shown by the numerous scientific publications appearing at present in Soviet Russia. To pass judgment upon the merits of many of these is beyond my scope; similar criticism could be applied to various scientific bodies in other countries as well.

One must also call attention here to the great progress made in lower education, with the result that within a brief period of time, the percentage of illiteracy has been greatly reduced. The most popular corner at a railway station or a club is the bookshelf full of new books and journals, sold at comparatively low cost, which are eagerly examined by people, most of whom could not distinguish one letter from another ten years ago.

Russia lives at present under a terrific strain in an attempt to change completely its economic and social structure. Everything that one needs to satisfy ones physical and spiritual needs is being dished out in minimum doses. The scientist and professor are not those that suffer most from this economic reorganization.

THE COMPOSITION OF BONE ASH

Dr. Sergius Morgulis

Professor of Biochemistry, School of Medicine, University of Nebraska

The investigation of the composition of bone is one of the earliest attempts at the study of the chemistry of animal tissues. The great preponderance of mineral matter in bony structures made it the favorite material for chemical analysis long before the other tissues of the organism were studied from this viewpoint. The older chemists have found that the mineral components of the bone contained a preponderance of basic radicles, but, dominated by a preconceived idea that the bone salts must be neutral, they have spared no effort to find extra acid radicles to account for the discrepancy. The result of this was rather disastrous so far as attaining a clear undertanding of the chemical nature of the bone is concerned. Only since the ideas and principles of physical chemistry have assumed a dominant rôle in the study of biochemical problems has there been a revival of interest in the chemistry of bone. The physical chemist, however, has attacked the fundamental problem of how a structure consisting of insoluble salts could be derived from soluble components dissolved in the circulating blood without the fundamental knowledge of the nature of the salts which constitute the mineral matter of bone. This and the lack of appreciation of the biological factors involved in bone formation such as vitamin, hormonal and possibly also enzyme factors has had the inevitable consequence. The problem, instead of having been clarified through the application of physico-chemical principles and methods, has been thrown into complete confusion. The extremely contradictory findings from this angle have finally forced even the physical chemist to realize that these findings may be independently correct and yet have nothing to do with the question of how the insoluble bone salts were deposited from the serum. A more recent attempt at a solution of the problem of the nature of the bone ash salts was inspired by the x-ray spectrophotometric analysis of crystal structure. It is still too early to appraise the true significance of the results of these x-ray spectrophotometric studies. Of the

very few studies so far made, some think definitely to have established that the basic component of the bone ash is of the nature of an apatite mineral, $Ca[(Ca_3(PO_4)_2)_3]CO_3$, i. e. a complex salt of $CaCO_3$ and $Ca_3(PO_4)_2$, thus accepting the view which was proposed by Hoppe some seventy years ago.

When one considers what different calcium salts constitute the basis of the bone ash (and quantitatively these represent by far the largest part), there is no doubt as to the presence of $CaCO_3$, but with regard to the $Ca_3(PO_4)_2$ some doubts have been raised. The chief objection to the latter, apart from purely physico-chemical considerations, is the fact that a *pure* compound of this nature is not known to exist. One can readily accept this as a valid objection without, however, being obliged to resort to an hypothesis that, instead of a tricalcium phosphate, secondary calcium phosphate, $CaHPO_4$, is the substance constituting the bone ash in combination with CaO. All the evidence, both from spectrophotometric and from chemical analysis, fails to support the idea that $CaHPO_4$ is a component of the bone salts. Is the apatite structure of the bone ash salts, namely, the complex calcium phosphate-carbonate, the only other alternative? Does the chemical analysis of the bone ash support such a hypotheis?

As a result of our study of the composition of the ash from the vertebrae of a large series of animals, from cartilaginous fish to mammals, we came to the conclusion that the bone ash cannot be a compound like $Ca[(Ca_3(PO_4)_2)_3]CO_3$. Our analyses were made on the bone salts after the organic matrix had been leached out by means of alkaline glycerol at about 250°. The ash so prepared and dried to constant weight was analyzed for Ca, Mg, K, P, CO_2. In addition, the ash solution made by dissolving a weighed quantity in a definite amount of 0.1 N HCl was titrated back with 0.1 N NaOH using methyl orange as indicator. In this way we were able to determine the balance of acid and basic equivalents in the ash. We found the following outstanding facts in our comparative analyses. The chemical composition of the salts of vertebrae is remarkably uniform. The only striking difference occurs between the vertebrae of the marine fishes and those of all other vertebrates examined, and this consists in the much lower $CaCO_3$ content found in the marine fishes. Whereas the calcium phosphate : calcium carbonate ratio is, on the average, 12:1 in marine fishes, in the other vertebrates it is 6.6:1. The other significant fact revealed by the analyses is the excess of calcium which cannot be accounted for either as phosphate or as carbonate, thus indicating that a third type of calcium compound must exist in the bone ash. Finally, it was found that the basic equivalents exceed the acid equivalents, the ratio between these two being, on the average, 19 to 18. We are therefore led to believe that the bone ash contains $Ca(OH)_2$ in addition to $CaCO_3$ and $Ca_3(PO_4)_2$. The fact that the residual Ca over residual P ratios in our analyses range from 1.99 to 2.13, whereas if the residual salt were only $Ca_3(PO_4)_2$ this ratio would be 1.94, also shows unmistakably that another calcium salt must be present in the bone ash.

In spite of the opinion, presumably sustained by x-ray spectrophotometric studies, that the $CaCO_3$ and $Ca_3(PO_4)_2$ are present in bone as an apatite compound, we must decline to subscribe to such a view for the following reasons. On the assumption of an apatite crystalline structure such as $Ca[(Ca_3(PO_4)_2)_3]CO_3$, one would expect that the phosphate : carbonate ratio in bone ash would be 9.3. As a matter of fact we have seen how in marine fishes this ratio is considerably higher while in the other vertebrates much lower than the theoretically expected ratio. Furthermore we know that this ratio also varies under pathological conditions as well as with age, mode of nutrition, etc. This would hardly be expected if the $CaCO_3$ and $Ca_3(PO_4)_2$ were parts of a definite crystalline compound. Finally, as will be shown presently, the carbonate and phosphate do not stand in a definite and simple *molar* ratio as would be expected from a chemical compound as distinguished from a mixture. According to our analytical results, the average composition of the bone ash of marine fishes corresponds to: 82.15% $Ca_3(PO_4)_2$, 7.00% $CaCO_3$ and 3.74% $Ca(OH)_2$. In terms of mols these values are 82.15/310, 7.00/100 and 3.74y74, thus giving a *molar* ratio of 6.00:1.57:1.13. Similarly, the average composition of the ash for all other vertebrates examined is 77.20% $Ca_3(PO_4)_2$, 11.81% $CaCO_3$ and 3.13% $Ca(OH)_2$, corresponding to a molar ratio of 6.00 : 2.82 : 1.02. It is interesting to observe in this connection that similar ratios may be obtained from bone analyses published by other investigators, and also from analyses of so-called tricalcium phosphate. The latter which we analysed so far may be of two distinct types, consisting of $Ca_3(PO_4)_2$ either with $Ca(OH)_2$ or with $CaHPO_4$, but in either case in a molar ratio of 6.00 : 1.00. Obviously, therefore, a simple compound $Ca_3(PO_4)_2$ does not exist by itself but always occurs as part of a complex salt, and in bone ash the evidence indicates that the same complex salt exists. It will be noted that between the carbonate and phosphate neither the molar ratio demanded by the hypothesis of the apatite structure nor any other definite molar ratio can be shown. The chemical analyses suggest that the basic complex salt composing bone ash is $Ca[(Ca_3(PO_4)_2)_6](OH)_2$.

BILE SALTS

Dr. Shiro Tashiro
Professor of Biochemistry, University of Cincinnati
L. H. Schmidt
School of Medicine, University of Cincinnati

While studying the toxic action of bile salts, we found that the administration of thyroid principle to the guinea pig increased the toxicity of the bile salts in much the same manner as Hunt found some years ago that the similar treatment increased the susceptibility of the rat to the toxic action of acetonitril. This increased sensitivity which, by the way, can also be demonstrated with arbacia and fish embryos, under limited conditions, is the most pronounced in the gastric ulcer producing action of bile salts in the guinea pig. Some of you probably know that Sellard discovered years ago that when a small amount of bile salts is injected into a rabbit or a guinea pig, ulcerations are produced in their stomach. The lethal dosage for this action is quite sharp under a given condition. In normal male guinea pigs, an intraperitoneal injection of less than 20 mgs. per 100 gms. body weight will not produce these ulcerations, but in the pig, fed with 0.2 mgs. of thyroxin twice or more, even 15 mgs. per unit weight will cause the lesion. With a greater thyroxin feeding and a smaller injection of bile salts, we find interesting results. With 12 mgs. of bile salts per unit weight, no guinea pig shows ulcer when the thyroid principle is fed once; when fed five times, 62% showed the lesion; and when fed ten times, 83% showed a positive lesion. I may add here that the thyroid administration not only increases susceptibility of the pig to the toxic action of bile salts, but it also produces a type of pathological picture which is similar to that found in the very acute gastric ulcer of man.

As to the mechanism by which the toxicity of bile salts increases under the thyroxin treatment, we are of an opinion that a change in lipoidal, or I should say, lipid metabolism, must be responsible. There are several lines of evidence to support this view. In the first place, it has been found in our laboratory that certain lipids such as lecithin, cephalin, sulpholipid (Tsuruta) and cholesteryl oleate (Ishii) are the only compounds which have power to protect the animal from this toxic action of bile salts.

In the second place, any conditions, physiological or otherwise, such as sex and seasonal variation, in which the lipid content of the body is different, manifest a different degree of resistance to the toxic actions of bile salts. For instance, sartorius muscle of a male frog requires less bile salts to produce tetanus than that of a female. The toxic dose required to produce ulcer in a male guinea pig is much smaller than in a female. Not only are these minimum toxic doses different, but also the amount of lipids required to neutralize the toxic effect of the bile salts differs with sex. It requires more lipids to antagonize the same amounts of bile salts with male than with female. The muscle of a winter frog is more resistant to bile salts than that of a spring frog. The more of these lipids the body contains, the more resistant it is toward toxic action of bile salts.

Since phospholipids are the most outstanding of all the antagonizers both in effectiveness as antagonizers and in the quantity occurring naturally in the body, we have attempted to discover whether or not the decrease in phospholipid alone can be responsible for the increased susceptibility of thyroid-fed animals to bile salts. The normal male guinea pig requires 18 mgs. of lecithin to antagonize 20 mgs. of bile salts, and the pig, fed with the effective amounts of thyroxin, requires 44 mgs. of lecithin to neutralize the same amount of bile salts. Therefore thyroxin treatment must have decreased antagonizers which correspond to 26 mgs. of lecithin in each 100 gms. of body weight, or 1 mg. of lecithin phosphorus. But the guinea pig contains only 8 mgs. of lipid phosphorus per 100 cc. of blood and consequently only 0.6 mgs. of blood lipid phosphorus per 100 gms. of body weight. In other words, the thyroid-fed animal must have lost about twice as much phospholid as contained in whole blood before treatment.

As a matter of fact, we found in rabbits that the decrease in blood phospholipid under similar thyroxin treatment is about 22%. Although it is highly probable that a rabbit and a guinea pig may not act in exactly the same manner, we are inclined to believe these data suggest very strongly that the decrease in phospholipid alone could not be responsible for this increased susceptibility. And certainly the thyroid administration must also diminish other antagonizers such as cholestryl oleate, but how much has not yet been determined. At any event we are certain that the phospholipid content of the body is a correct index of its resistance against bile salts. From these and other evidences, that I can not go into now, we wish to conclude that the gastric ulcer in the human is a metabolic disease involving lipids, and that hyperthyroidism is one of the most aggravating conditions for the gastric ulcer, particularly in the male.

THE ENOLIZATION OF GELATIN BY NEUTRAL SALTS

DR. J. M. JOHLIN
Assoc. Professor of Biochemistry, School of Medicine, Vanderbilt University

Loeb's well known studies show that the action of neutral salts on gelatin can be accounted for on the basis of Donnan's theory of membrane equilibria and can be predicted and quantitatively expressed by a mathematical equation. These explanations, however, do not hold in the case of gelatin which contains neither acid nor base. The writer has found, for instance, that a neutral salt added to a solution of gelatin, which is entirely free of acid and base, or contains but very small amounts of these reagents, increases rather than decreases the viscosity of such a solution. Loeb found that a neutral salt added to a solution of gelatin at a pH of 3.0 did not affect the hydrogen ion concentration. The writer has found that when no acid, or when but small amounts are present, a neutral salt increases the hydrogen ion concentration of such a solution.

Aside from any consideration of the probable effect of a neutral salt on the hydrogen ion activity of gelatin it seemed possible that this increased acidity might be due to the enolization of the gelatin by the neutral salt. Such an effect had, so far as is known, not been observed before. Pauli and his co-workers had, on the contrary, found that neutral salts do not affect the optical activity of proteins. The writer found in his experiments that a considerable number of neutral salts greatly affected the optical rotation of solutions of ash-free gelatin and that small amounts of acid produced no similar effect.

This action of neutral salts, which is assumed to be that of a tautomeric displacement involving the equilibrium between the keto and the enol forms of the protein, is proportionate to the salt concentration. The explanation given for this effect does not exclude Hardy's postulation of a union between the neutral salt and the nitrogen of the protein.

OXIDATIONS PRODUCED BY GONOCOCCI

DR. E. S. GUZMAN BARRON
Assistant Professor of Biochemistry, University of Chicago

It is well known that many bacteria possess the power of oxidizing not only the simple carbohydrates but also their fermentation products, since aerobic growth is known to occur on lactate, acetate, succinate, glycerol, etc., when these form the only source of carbon. During the last years those investigators concerned with the problem of cellular oxidations, have studied some bacterial oxidations with great detail. It seems obvious that for a comprehensive study of cell oxidations we ought to look for those cells possessing an oxidation mechanism as simple as possible, uncomplicated by oxidation processes beyond the investigator's control, such as endogenous oxidations.

A suspension of gonococci washed twice in saline solution (0.154 M NaCl), and buffered at different pH's from 4 to 10, does not show any appreciable oxygen consumption when the proper aseptic precautions have been taken. This absence of endogenous respiration renders the material an excellent one for the study of cell oxidations. The following substrates have been used: glucose, Na lactate, pyruvate, acetate, formate, succinate; glycoccoll, d-alanine, all of which are oxidized by B. Coli according to Cook and Stephenson. Gonococci are able to oxidize only the first three substrates. None of them is oxidized to completion. One mole of glucose takes up two moles of oxygen; one mole of lactate takes up one mole of oxygen, and one mole of pyruvate requires one atom of oxygen. The velocity of oxidation of these substrates is as follows: lactate < glucose < pyruvate. The effect of pH on the activity of oxidation of these substrates has been studied. Glucose and lactate show an optimum activity from pH 6.3 to 6.9: Pyruvate from 6.5 to 7.0. From this optimum plateau the velocity of oxidation falls asymptotically. Glucose and pyruvate are not oxidized at pH's 5 and 9. Lactate is oxidized within wider limits: from pH 4.6 to pH 10. At pH's 5 and 9 lactate is oxidized to pyruvic acid. By changing the pH of the bacterial suspension it is possible to dissociate the process of lactic acid oxidation in two steps: first step, lactic to pyruvic; second step, pyruvic to acetic. We can therefore picture the chain of reactions taking place when one mole of glucose is oxidized by gonococci, as follows:

$C_6H_{12}O_6$ gives $2CH_3CHOHOHCOOH$ (Hydrolysis)

$2CH_3CHOHCOOH$ plus O_2
gives $2CH3COCOOH$ plus $2H2O$

$2CH_3COCOOH$ plus O_2 gives
$2CH3COOH$ plus $2CO2$

KCN at 0.001 M concentration inhibits the oxidation of these three substrates, although at different levels. The oxidation of glucose and pyruvic acid are inhibited about 80 per cent. The oxidation of lactate is almost completely inhibited.

Reversible dyes act in the same manner as in normal tissues; they increase the oxygen consumption only when the oxidizing enzymes have been inhibited by cyanide.

SCIENTIFIC BOOKS

Adventures in Biophysics. A. V. Hill. 162 pp. University of Pennsylvania Press. $3.00.

This book contains five lectures given by Professor Hill during the autumn of 1930 in Philadelphia under the auspices of the Johnson Foundation for Medical Physics. Not all of Hill's unusual appeal as a lecturer, his magnetic personality, his sense of the value of "human interest," has been lost in the fixation of these lectures on the printed pages. Both the general physiologist and the biochemist will read the book with a fascination that makes its title, "Adventures," seem well chosen.

The five lectures are entitled: I. Some Adventures with Vapor Pressure; II. The State of Water in Tissues; III. The Conception of the Steady State; IV. The Time Relations of the Events in Muscular Contraction and V. The Mechanics of Muscular Contraction and Other Matters.

In the first lecture, he explains how some anomolous results in experiments on the heat production of muscle, measured with a delicate thermopile, proved to be due to the change in vapor pressure of muscle fluid as its osmotic pressure rises during activity. This apparent defeat was turned into victory and the very delicate instrument "made to expiate its crimes" by using it as a convenient and surprisingly accurate means for measurement of small differences in osmotic pressure. Applications of this method are the chief subject material of the second lecture which brings out the idea that, contrary to much of the recent tendency of adsorption theories, nearly all of the water of muscle and other tissues appears to be "free" in the sense that it can act as a solvent.

The third lecture develops the thesis that the steady state in living things must be regarded as dynamic, as due to sustained expenditure of energy, not as equilibrium. The experiments chosen to prove and illustrate this idea are mostly those dealing with osmotic pressure differences and adjustments but they cover a wide range of biological material. The varied mechanisms of these adjustments "will provide an excuse for many of us, for some time yet, to work in laboratories by the sea."

In the fourth lecture, Hill presents interesting and suggestive new ideas concerning the problems of muscular contraction, while pointing out how far we are from an understanding of either its chemistry or its mechanics. He pays considerable attention to the relative significance of phosphagen breakdown and lactic acid production both in this and in the last lecture which is chiefly concerned with the relations between total energy liberation and the heat production during muscular contraction.

To research workers, the book should be useful practically, because of descriptions of special instrumets and an excellent bibliography; inspirationally, because of its unbiased presentation of the present unsatisfactoriness of theories of muscular contraction and of dynamic equilibrium, while clearly pointing out for these mysteries some of the clues which hold promise for immediate investigation. —Philip H. Mitchell.

Heredity. A. Franklin Shull. 2nd ed. xv-345 pp. McGraw-Hill. $3.00.

The new edition of "Heredity" by Dr. A. Franklin Shull shows several points of improvement over the first, excellent as that was. Designed as a text for a lecture course for beginners, it fulfills its purpose admirably. The chapters are concise, unified and clearly written, the illustrations well chosen and not too numerous, the subject matter up-to-date and critically selected. The introduction of material on chromosomes and sex in plants and especally the addition of problems at the end of each chapter are to be highly commended. Other changes, all for the better, are the expansion of the first chapter on Rise of Knowledge of Heredity, the revision of chapters on Immigration, Population Problems, Evolution and Heredity in Man, the addition of sections on multiple allelomorphs and lethal homozygotes. The discussion of human heredity and of engenics is critical and restrained.

Two impressions given are questioned: one, the restriction of the use of the term F1 to generations or individuals derived from homozygous parents and of F2 to progeny of such heterozygous F1 individuals: the other, the statement in the chapter on linkage that "several instances of linkage in man are known." The reviewer has supposed that although sex linkage has been proved in man, not even the various sex-linked factors have been proved to be linked with each other. The reviewer has also found it more satisfactory in teaching to introduce multiple allelomorphism and sex-linkage after monohybrid crosses and to postpone a discussion of evidence for location of genes in chromosomes until after the preentation of linkage and sex-linkage, since these phenomena strengthen the discussion. These are, however, merely points of order and in no way lessen the value of the book for the purpose for which it is intended

Anna R. Whiting.

The Collecting Net

A weekly publication devoted to the scientific work at Woods Hole.

WOODS HOLE, MASS.

Ware Cattell .... Editor

Assistant Editors

Margaret S. Griffin Mary Eleanor Brown

Annaleida S. Cattell

THE COLLECTING NET SCHOLARSHIPS

Each summer for the last three years THE COLLECTING NET has been successful in accumulating the sum of five hundred dollars for its scholarship fund. In the Fall the money is awarded in the form of five one hundred dollar scholarships to assist promising students financially at Woods Hole during the following summer.

These five scholarships will be available again this year for work at one of the local scientific institutions in 1932. They will be assigned in September by a committee of senior investigators. Any student taking a course at the Marine Biological Laboratory and having the following qualifications is eligible for the award:

The student must show evidence of ability to engage in research work. Judgment of this ability will in part be based on a written report of problem work done at Woods Hole during the summer. Such work need not necessarily be done in connection with the course. Preference will be given to students who without such financial assistance would be unable to attend the 1932 session of the laboratory. The student must engage in a full-time research problem at the Marine Biological Laboratory for a period of at least six weeks during the summer of 1932.

Application blanks may be obtained from the director of any course or from the office of THE COLLECTING NET. A summary of work accomplished during the period in which the scholarship is held will be printed in our magazine.

Professor Hans Spemann, who is now visiting the Marine Biological Laboratory, comes to us with no need of an introduction. He is an outstanding student of the physiology of development. Trained by Boveri at Wurzburg, he spent his earlier years instructing in the laboratory of his teacher. Later he accepted an appointment at the Kaiser Wilhelm Institute fur Biologie at Berlin-Dahlem, where he shared in the directorship of the laboratories. From Dahlem Professor Spemann went to Freiburg in Breisgau where he is director of the Zoological Institute. There he and his students are continuing his studies of developmental phenomena in the newt, Triton. In a series of experiments extending over a thirty-year period, he has tested the relationships between the parts of the developing amphibian germ. The results have demonstrated the wide application of the principle of induction as a fundamental process in development and the value of certain units as centers of organization. Professor Spemann's contributions are among the most stimulating to all students of developmental problems.

THE COLLECTING NET is indebted to Mr. Charles P. Titus of Carl Zeiss, Inc. for the use of his telephone. Through his accommodation, THE COLLECTING NET may be reached by calling Falmouth 993-M.

Dr. Helen Miller of Johns Hopkins University, Baltimore, has had her National Research Fellowship in zoology renewed and will spend the coming year in the department of Professor L. L. Woodruff at Yale. Dr. Daniel Raffel, a National Research Fellow in the department of genetics, Johns Hopkins University, has been reappointed and will continue his work in Professor Woodruff's laboratory at Yale.

Mr. John A. Kyle, manager of the Natural Science Department of the Clay-Adams Company, is now vacationing at Woods Hole. He is staying at the Column Terrace, Falmouth.

Dr. A. K. Parpart, who received his doctor's degree from the University of Pennsylvania this Spring, has accepted an appointment as instructor in the department of physiology at Princeton.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the hole turns to run from Buzzards Bay to Vineyard Sound:

Date	A. M.	P. M.
Aug. 1	6:51	7:09
Aug. 2	7:35	7:51
Aug. 3	8:13	8:34
Aug. 4	8:59	9:21
Aug. 5	9:45	10:14
Aug. 6	10:32	11:07
Aug. 7	11:20	
Aug. 8	12:01	12:16
Aug. 9	12:55	1:10
Aug. 10	1:52	2:03
Aug. 11	2:43	2:51

In each case the current changes approximately six hours later and runs from the Sound to the Bay. It must be remembered that the schedule printed above is dependent upon the wind. Prolonged winds sometimes cause the turning of the current to occur a half an hour earlier or later than the times given above.

ITEMS OF INTEREST

MT. DESERT ISLAND BIOLOGICAL LABORATORY

Admiral Byrd was present at a picnic supper held on the shore by Dr. and Mrs. Warren H. Lewis, Tuesday, July 21, 1931.

Dr. and Mrs. Homer W. Smith of New York University have applied for the Laboratory lot adjacent to that of Dr. Robert Hegner. Dr. and Mrs. Smith expect to build a summer cottage in the near future.

On Thursday, August 6th, Dr. Warren H. Lewis will give the fourth lecture in the Popular Lecture Course. His subject is "Cancer Problems" and he will show motion pictures.

Dr. and Mrs. William Wherry of Cincinnati, Ohio, are entertaining the Laboratory at a barn dance, Saturday, August 1st.

Dr. and Mrs. E. K. Marshall, Jr. invited the older members of the Laboratory to tea Sunday afternoon, July 27th

The Monday evening seminar will be given on August 3rd by Dr. Harold D. Senior of New York University and Dr. A. Defrise of the University of Milano, Italy.

FRANCES R. SNOW, *Secretary.*

Mr. and Mrs. Henry Finch announce the engagement of their daughter, Kathleen May, to Dr. Lester G. Barth. The marriage will take place the latter part of August at the Finch's home in Boston. After a motor trip to Detroit and Chicago, the couple will return to New York City where Dr. Barth will be an instructor in zoology at Columbia University.

Miss Cornelia L. Carey, professor of bacteriology at Barnard College, after having been West for several weeks, has arrived at her home in Quissett to spend the rest of the summer.

Dr. Florence Peebles, professor of biology at the California Christian College, Los Angeles, has returned to the laboratory after two years absence. She is planning to work on the transplanting of organizers in Fundulus eggs. Dr. Peebles is living at Charles Grinnell Jr.'s house, having recently sold her cottage, "The Lantern," on Gardiner Road, to Dr. May Wilson of the Medical School of Cornell University.

Miss Jean Henderson, a lecturer in the department of zoology, McGill University, is spending the summer as an investigator at the Bermuda Biological Station for Research.

CORNELL UNIVERSITY BIOLOGICAL FIELD STATION

Dr. Umma Shuma Sharga has recently arrived from the University of Edinburgh to study entomological control methods in this country before returning to India. He will remain in Ithaca about a year. At present he is making a study of the aquatic population of our waterfalls.

Dr. Elizabeth Genung of Smith College addressed a meeting of Sigma Delta Epsilon, Graduate Women in Science, on July 20th, on her African travels.

Mr. Alexander B. Klots has accepted a position with Wards Natural Science Establishment as head of the Entomological Department. He will also be an Associate in Entomology at the University of Rochester.

Dr. Clyde Fisher of the American Museum of Natural History is teaching in the University Summer Session, in the absence of Prof. E. L. Palmer who is at the University of Hawaii.

Prof. J. C. Bradley left this week for a few weeks of Entomological collecting in Florida.

Prof. and Mrs. Needham are receiving congratulations on the birth of a second grandchild. James George Needham II is the son of Mr. and Mrs. William R. Needham.

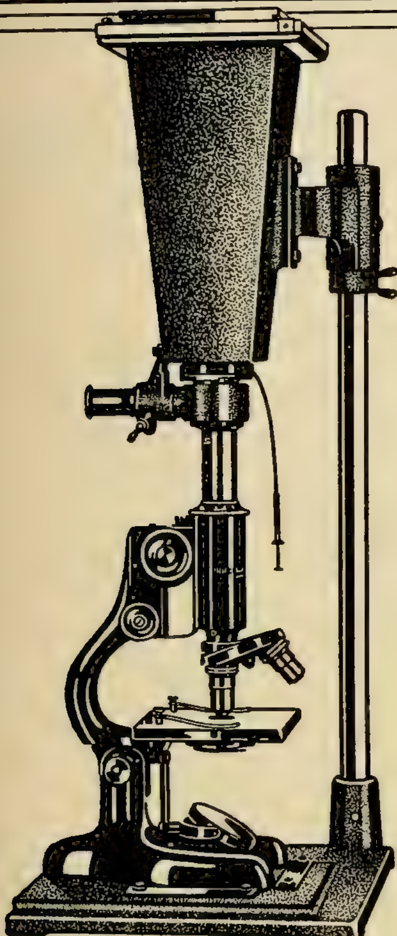
—ELSIE BROUGHTON KLOTS.

On Tuesday, July 28th, Miss Ida T. Genther was married to Mr. L. Herbert Schmidt at 10:30 in the Church of the Messiah. Miss Genther will be remembered as one of the investigators at the Laboratory last summer. She has been doing research work in Cincinnati this past year. Mr. Schmidt, who is a research fellow in biochemistry at the Medical School at the University of Cincinnati, is working with Dr Tashiro at the Laboratory this summer. Miss Sybil Street was the bride's only attendant and Mr. E. M. Adams was the best man. The ceremony was performed by the Rev. James Bancroft.

Dr. Eugene DuBois will be the speaker of the afternoon at the weekly forum on Sunday afternoon, August 2nd at Dr. Warbasse's estate on Penzance Point. His talk will be on "Some Physiological Aspects of Submarines and Deep Diving."

On Sunday, August 2nd, Gilbert and Sullivan's operetta, "The Mikado," will be given in the M. B. L. Club at 8 P. M.

On Thursday evening, August 6th, at 8 p.m. there will be a victrola concert in the M. B. L. Club. Sibelius' Symphony No. 1 and Stravinsky's Fire-Bird will be presented.



THE WOODS HOLE LOG

The Woods Hole Choral Club gives its fifth Annual Concert Saturday evening, August 8, at eight-thirty in the Auditorium. Most of the fifty singers who have been practicing during July are biologists, but membership is not limited to Laboratory workers; the club is open to all who like to sing and who are willing to practice for an hour after the Tuesday and Friday lectures.

Mr. Ivan Gorokhoff, director of choral music at Smith College, is again the conductor. He is remembered by the older laboratory workers as the leader of the Russian Cathedral Choir which gave a concert at Mr. Crane's residence some years ago.

The program consists of two parts; sacred music, mainly from the service of the Russian Church, and secular songs. The German composer Handel is represented by four choruses from some of his less known operas and oratorios. Here is the complete program.

Cherubim Song	*Musitcheskoo*
Only Begotten Son	*Gretchaninoff*
O praise ye the Name of the Lord	*Kastalsky*
Then round about the starry throne	*Handel*
The heart that's contented	*Handel*
May no rash intruder	*Handel*
The foolish lover squanders	*Handel*
Wassail Song	*Williams*
Bylinka	*Kastalsky*
The Brook	*Arkhangelsky*
Dusk of Night	*Arkhangelsky*

Tickets for the concert will be on sale soon for $.50 and $1.00.

On Thursday, August 6th, Falmouth will be gay with the annual fete for the benefit of the Nursing Association. From three until eleven thirty p. m., the town will be busy raising money to support the organization during the coming year. Booths will be installed on the Village Green and, as a special attraction, there will be block dancing with the 13th Regiment Band of Whitman supplying the music.

Early Tuesday evening the fire siren summoned most of Woods Hole to a spectacular boat fire at the wharf beside the Penzance Garage. A speed boat, owned by Mr. Aranaze of Falmouth, caught on fire when the engine backfired over by Cahoon's wharf. The boat could have been saved by efficient handling, but instead they took her out in the breeze and managed to get her over to the dock behind the Fire House. The insignificant blaze became serious when the gasoline tank exploded and by the time the fire was put out, the boat was a total ruin. The two occupants of the boat were uninjured although Mr. Aranaze's hair was singed and his companion was blown out of the boat. The present owners carried no insurance.

The laurels of this week's production at the University Players' Theatre go to Peter Wayne, "the cardboard lover" himself, in Jacques Duval's clever little skit of that name. The adaptation by Valerie Wyngate and P. G. Wodehouse is very witty and although the plot is a totally trivial love intrigue, the play affords a delightful evening in the true French manner.

Simone divorced her husband, Tony, for his infidelity, though she still loved him. When he comes back to seek her again for his wife, she hires the young Andre to be her lover only in name, as a protection to save herself from giving in to Tony. Andre, the cardboard lover, is only too faithful in carrying out his duty of interrupting her tete-a-tetes with Tony and the comedy revolves in a whirl around these three; Simone who wants Tony and regrets the day she hired Andre to be her "shadow;" Tony, the egotist, who wants Simone and is used to being irresistible to women; and Andre, poor, in love with Simone, who is forced by his contract into an unusual and false position.

Simone, as played by Katherine Hastings, was delightful, though a little too much the young, impetuous, American college girl to be truly convincing as a French madame. Henry Fonda as Andre was thoroughly satisfactory and looked the part of a French monsieur. Freida Altman, who played one of the leads in "Interference," made a superb French maid.

Peter Wayne as Andre played an unconvincing role in a convincing manner. Though the part did not enable him to reach the heights of character-acting that he attained as Philip Voaze in "Interference," he, nevertheless, made the most of his role.

The sets were very effective but there is one complaint to be made against all the scenery of the season and that is the poor construction of the doors. They are amateurish and do not close and open with facility and without causing a trembling of the adjoining walls.

The Players are busy now rehearsing "The Trial of Mary Dugan" with Cynthia Rogers in the title role. The cast required is so large that practically the entire group will have to take parts and the stage will be enlarged. The business in the court room will begin at 8:15 next week, although the action of the play itself will not start until the usual time of 8:30. —M. S. G.

THE WOODS HOLE LOG

A protest against the present prices of gasoline on the Cape has been filed by the Cape Cod Chamber of Commerce, which contends that the higher prices prevailing here are harmful to trade in general.

Gasoline prices on the Cape average about 17½ cents a gallon, which is from four to five cents higher than other parts of the state. The retail price is based on the firms' prices to filling stations. Gasoline officials claim that prices on the Cape are normal but that prices in New Bedford, Boston and other cities are abnormal at the present time because of a price war between rival companies.

H. S. Dowden, secretary of the Cape Cod Chamber of Commerce sent the following telegram to the Federal Trade Commission:

> The Cape Cod Chamber of Commerce calls your attention to the price of gasoline on Cape Cod, four and five cents higher per gallon than all other points in the state. This is harmful to all trade here and it gives the impression that other commodities are in the same proportion.

Following the telegram, a letter was dispatched, as follows:

> Confirming our telegram, the Cape Cod Chamber of Commerce urges your assistance in adjustment of the price of gasoline on Cape Cod, which is four and five cents higher than in all other points in the state.
>
> I am enclosing a map showing the towns affected. In the town of Bourne, the price is 13½ cents and 14½. Other points on the Cape range from 17.4 cents to 17.6. In New Bedford gasoline is selling for 12½ cents to 13½ in company owned stations.
>
> This is very harmful to all trade here as it gives the impression, especially to our summer visitors, that all other commodities are in the same proportion.

Last October the Cape Cod Chamber of Commerce and the Selectmen's Association launched a drive against the high price of gasoline and within a week the price fell between two and four cents.

The Cygnet, a two masted auxiliary schooner yacht, seventy-five feet long, bound on a swordfishing trip, ran aground at Chilmark early Wednesday morning, July 23rd. Captained by John Carr of New York City, the vessel was headed for Vineyard Sound when she ran ashore in a dense fog. Captain Carr and his crew of four were forced to swim about twenty-five feet to shore; and in the dash for safety one of the crew sprained an ankle and was removed to the Vineyard Haven Marine hospital. Two patrol boats from the base here at Woods Hole went to the rescue and finally towed her in to New Bedford, arriving about nine o'clock at night.

On Monday evening, July 27th, the Coast Guard received a call from H. W. Morse whose yawl, "Onawa," went aground at the entrance of Edgartown harbor. In less than an hour after the call was received, the yawl was pulled off, undamaged, by the patrol boat, C. G. 286.

Recently two members of the Marine Biological Laboratory sailed to Martha's Vineyard. On their return trip, the boat was incapacitated and they were picked up by a fishing vessel. The young man amused himself by taking pictures of the girl with the members of the crew. One of the fishermen asked to have a picture sent to him, leaving his name and address with the girl.

When the pictures were developed, the girl sent one to the fisherman. A few days later, the administration office opened a letter addressed to "The Marine Biological Laboratory, Woods Hole, Mass.," and were surprised to find the following:

> Whoever opens this letter will you please place the letter and the picture in the hands of the lady whose face appears in this snapshot. I admire your nerve in addressing my husband with such affectionate terms as "My Dear Mr.—" and telling him you had nct forgotten him but my advice to you is to forget him and not to correspond any further with him. Maybe you did not know he was married but I am telling you ncw that he is. I am sorry I can't address you by name but my husband tore ycur signature from the letter, thinking I would not be able to write you. (Signed) Mrs. George P. —,
> Provincetown, Mass.

On Sunday, August 2nd the Rev. Mr. Herman R. Page, rector of St. Paul's Church, Dayton, Ohio, will preach at the 11 o'clock service at the Church of the Messiah. He is spending the summer at Vineyard Haven.

TIDE TABLE AT BREAKWATER BEACH

At the following hours (Daylight Saving Time) it is high water at the Breakwater Beach:

Date	A. M.	P. M.
Aug. 1	10:39	10:48
Aug. 2	11:13	11:03
Aug. 3	11:59	. . . .
Aug. 4	12:11	12:40
Aug. 5	12:59	1:25
Aug. 6	1:46	2:11
Aug. 7	2:43	3:00
Aug. 8	3:40	3:54
Aug. 9	4:34	4:47
Aug. 10	5:31	5:46
Aug. 11	6:28	6:40

Approximately six hours later, the tide is low.

THE COLLECTING NET

Vol. VI. No. 7. SATURDAY, AUGUST 8, 1931 Annual Subscription, $2.00
Single Copies, 25 Cts.

EXPERIMENTS ON THE AMPHIBIAN EGG

DR. HANS SPEMANN
Director of the Zoological Institute at Freiburg

It gives me great pleasure, and I consider it a high honor, that I may speak to you of my experiments. I see amongst you some of those men who, from the earliest days of my scientific career, I always looked upon as upon heroes of our science; I see young scientists whom I wish to fill with enthusiasm for the experimental embryology.

First, before entering on my lecture, I wish to acquaint you with a good old friend of mine —the newt's egg—which has accompanied me for the greater part of my life. These eggs of the newt may always be found during spring and early summer in the aquaria where the adult animals are kept, attached by the female to leaves of water plants. The egg is covered by a thin vitelline membrane and by an outer shell of elliptical shape, very soft immediately after the egg has been laid, but soon becoming rather hard and elastic. In order to (*Continued on Page* 173)

M. B. L. Calendar

TUESDAY, AUG. 11, 7:30 P. M.

Seminar. Dr. W. H. F. Addison, "Aquatic Mammals—A Description of a Special Cell type in the Cerebellum."

Dr. C. C. Speidel, "Living Nerve Sprouts."

Dr. J. E. Kindred, "Histologic Effects of Ligation of the Vasa of the Spleen of the Albino Rat."

Dr. G .S. deRenyi, "The Effect of Radium Irradiation upon the Ovaries of the Albino Rat."

FRIDAY, AUG. 14, 8:00 P. M.

Lecture. Dr. F. L. Hisaw, professor of zoology, University of Wisconsin, "The Corpus Luteum and Anterior Lobe Hormones and their Physiological Interrelationships."

THE UNIVERSITY OF MICHIGAN BIOLOGICAL STATION

GEORGE R. LARUE
Director of the Laboratory

The University of Michigan Biological Station had its origin in 1909 when Professor Reighard, now Professor Emeritus of Zoology in the University of Michigan, and Professor Burns, now Professor of Botany in the University of Vermont, with a group of 13 students became interested in making an intensive study of the animals and plants of Michigan in their natural surroundings. It was desirable to establish a station within a region as little disturbed by man as possible and at the same time readily accessible for transportation of supplies and equipment.

During the twenty-three consecutive years of its existence the Biological Station as a physical plant has grown from a few tents to 125 buildings of wood, concrete and steel construction. The faculty has been increased from two to fifteen members and the student body from 13 to 107 students. The membership of the Station including students, faculty,

TABLE OF CONTENTS

LABORATORY BUILDINGS OVERLOOKING DOUGLAS LAKE

A VIEW OF THE MICHIGAN BIOLOGICAL STATION FROM THE HILLSIDE BACK OF THE CAMPUS

investigators, and the various staff members and families now numbers more than 190 people.

The Station is situated on the shores of Douglas Lake on the tip of the Lower Peninsula of Michigan and is almost equidistant from Cheboygan, Mackinaw City and Petoskey. It is located on the Bogardus Tract, an area of more than 3,300 acres of land which extends from Douglas Lake to Burt Lake on the south, and has a combined frontage on the two lakes of more than six miles. The Bogardus Tract is the property of the University of Michigan and is occupied exclusively by, and devoted to, the Biological Station. Except for two small summer resorts on Douglas Lake, the region for miles about is almost uninhabited.

The Douglas Lake region is peculiarly well adapted for biological studies. This part of Michigan is diversified by hills and valleys, and was formerly covered by virgin forests of hardwoods and conifers. Small tracts of the former remain. Over most of the area second growth forests are becoming well established. The region contains many lakes of clear water, unsurpassed in the State for size, depth, and beauty of setting. Douglas Lake is of irregular outline, two and one-half miles wide and four miles long. Its wooded shores are in some places low and receding; in others they rise in terraced bluffs seventy feet high. The beach is of clean sand or stony, and the lake bottom, except for occasional abrupt drops, slopes gradually into deep water. This great variety of conditions ranging through a complete series of situations from lakes to hills and in the transitional zone supports a large number of species of plants. For these reasons, also, the region is equally well supplied with a varied animal population, being particularly rich in its invertebrate fauna.

The Station is located on a narrow strip of

THE DINING ROOM AND THE BOTANY LABORATORY

THE HEALTH SERVICE COTTAGES MAY BE SEEN IN THE DISTANCE BETWEEN THE TWO BUILDINGS IN THE FOREGROUND

level ground along the south shore of the east end of Douglas Lake. The plan consists of two streets paralleling the shore and connected by cross streets. There are three main divisions of the Station, the central portion or campus, the west end or residence areas for men and married students, and the east end or residence areas for women students, faculty, other staff members, investigators and health service. The entire Station is adequately supplied with a sanitary system and a water system. The campus and the west residential area are equipped with electric lights and it is hoped that in the near future the lighting system can be extended to the east residential areas as well.

The residence cottages are of two types, wood-sheathed with metal covering, or wood-sheathed and covered with slate-surfaced roofing felt. All have concrete floors, screened windows, screened doors, and stoves. They are equipped with beds, tables, chairs, and other necessary furniture. The cottages occupied by the men and married students are of the wood and metal type, 14 x 14 feet square in floor dimensions, and equipped with electric lights. All other cottages have the slate-surfaced roofing felt covering. Those occupied by the women students and the investigators are 14 x 16 feet, and those occupied by the faculty families are 14 x 34 feet in floor dimensions.

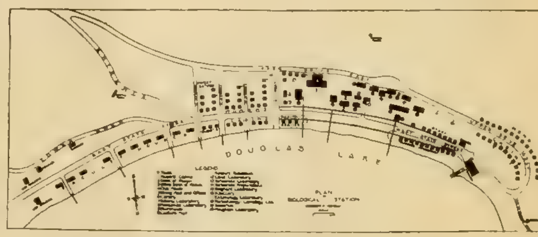
On the campus proper are located the buildings used in common by all members of the Station. The largest of these is a two-story administration building of steel and concrete construction, housing the administration offices, photographic rooms, stock rooms, store, post-office and kitchen storage below, and a kitchen and dining room above. There are nine laboratory buildings housing 13 laboratories, a library building, an aquarium, an insectary, an animal house, a club house, shop, tool room, garage, and keeper's house. Near the campus to the east are the hospital, physician's residence and office, and to the west a boathouse with a covered harbor.

The Station is adequately equipped to care for the demands of students and investigators. For transportation of classes and supplies the Station owns three trucks, several launches, outboard motors, and rowboats. Other equipment for class use includes nets, seines, traps, cameras, field glasses, microscopes and accessories, microtomes, aquaria, pens, cages, a large supply of minor equipment and a good working library. The zoological laboratories have large collections of bird skins, mammal skins, and skulls and many preserved specimens of reptiles, amphibians, fish and parasite worms. The herbarium includes nearly all of the flowering plants of the region.

At the Station class work is conducted in six courses in botany and seven courses in zoology, and in addition many students and faculty members are engaged in special problems of investigation in both botany and zoology.

The botanical faculty consists of four members; Dr. John H. Ehlers, assistant professor of botany, in charge of systematic botany, Dr. Carl D. LaRue, assistant professor of botany, in charge of work in plant anatomy, both from the University of Michigan; Dr. Frank C. Gates, professor of botany in the Kansas State Agricultural College, in charge of work in plant ecology, and Dr. Hempstead Castle, assistant professor of botany in Yale University, in charge of the work in lower plants. Professor Castle is new at the Station this summer, having been called to take over the work of Professor George E. Nichols, also of Yale, who was unable to return to the Station this year on account of ill health.

The zoological faculty is made up of eight members whose fields of interest follow their names. From the University of Michigan are:



PLAN OF THE BIOLOGICAL STATION

Dr. George R. LaRue, professor of zoology, Director of the Station and directing research in animal parasitology; Dr. Paul S. Welch, professor of zoology, directing class and research work in limnology; Dr. Frank N. Blanchard, assistant professor of zoology, ornithology; and Dr. Frank E. Eggleton, instructor in zoology, limnological methods. Those from other universities are: Dr. Herbert B. Hungerford, professor of entomology in the University of Kansas, entomology; Dr. William W. Cort, professor of helminthology in Johns Hopkins University, parasitic worms; Dr. Charles W. Creaser, associate professor of zoology in the College of the City of Detroit, vertebrates other than birds; and Dr. Lyell J. Thomas, assistant professor of zoology in the University of Illinois, working with Professors LaRue and Cort in helminthology.

Other new members of the staff are Alfred H. Stockard, instructor in zoology in the University of Michigan, Secretary of the Station; Jewel F. Stockard, dean of women, substituting for Grace Walker Nichols, who was unable to be present

at the Station this year; and Dr. Maurice R. McGarvey, physician at the Health Service in the University of Michigan, Station Physician.

With a teaching staff composed of men of recognized authority in their fields and drawn from several leading universities, the Station is given the advantages both of excellent teaching and direction of research, and of broader contacts with scientific spirit and progress over the country than could be had from a staff drawn from any one university. The coming together each summer of the staff from the several parts of the country brings something of the spirit of a scientific meeting in that thought and discussion for the entire summer are centered on the various phases of biology.

The courses taught at the Biological Station deal with those phases of biology which can best be learned by close contact with the undisturbed plants and animals in their natural habitats; or by the study of those plants and animals in the laboratory in relation to their natural habits and habitats. All courses essentially systematic in nature, as systematic botany of the flowering plants, ferns, mosses and algae, entomology, ichthyology, herpetology, ornithology and mammalogy, as well as plant anatomy, are conducted with considerable emphasis placed on living appearances, habitats, and natural histories of these forms. The Station is particularly suitable for the ecological studies—plant ecology, limnology and parasitology.

The student population of the Biological Station is an inspiring study within itself. Of the 107 students enrolled this summer eighty-four, or 77%, are graduate students, and twenty-three are undergraduates. Thirty-six of them, or one third, claim Michigan as their home state. Of the remaining seventy-one, fourteen come from Illinois, nine from Ohio, nine from Pennsylvania, six from Minnesota, five from Indiana, four from Wisconsin, three from Iowa, three from Massachusetts, two each from Connecticut, Mississippi, Oklahoma and West Virginia, and one each from California, Georgia, Kansas, Missouri, North Carolina, Tennessee, Texas, and Utah, and one from China.

While the large number of out-of-state students at the Biological Station entails considerable additional expense to the State of Michigan, the contributions of these students are worthy of consideration. In the same way that the faculty members from various parts of the country bring contacts and ideas of the progress of the country with them, the students make the Station a cosmopolitan institution. Many of the graduate students as well as the faculty and visiting investigators, both while here and back at their winter residences, are engaged in working out problems concerning animals and plants of this part of Michigan, and as a result the biological situation of the Douglas Lake region is perhaps better known than that of any other region in North America, excepting that of Woods Hole.

Many productive botanical investigations are being carried out at the Station. The situation and equipment are best adapted to work in plant ecology, taxonomy, and physiological and ecological anatomy, and many contributions in these phases of the subject have been produced. At present twelve investigators are working in botany with very encouraging results.

Because of its large variety of plant habitats the Douglas Lake region is particularly suitable for work in fresh-water algae and bryophytes. Over one hundred genera with 450 species of algae and 282 species of bryophytes are found there. Of these bryophytes 115 have not been recorded from other parts of Michigan.

With the great variety of habitats, the richness of the plant life and the abundance of ecologically related invertebrate fauna always on hand, work of an ecological nature is pursued to excellent advantage. These conditions also provide an abundance of material for investigation, both in the laboratory and in the field, in ecological and physiological anatomy.

General entomology is receiving a good share of the attention of investigators. Contributions from the Station in this field have been numerous, and the solution of each problem unearths new problems for solution. This summer five investigators are conducting research in entomology.

The opportunities for investigations in limnology are very favorable. At the present time eight people at the Station are pursuing problems in this field, five in general limnology and three in aquatic entomology. The limnological situation and equipment are quite adequate for the determination of life-histories and ecological relationships.

Researches in parasitology have been particularly productive, and at present fourteen people are carrying on investigations in parasitology. The subjects under investigation by this group are quite varied. The largest number on any one phase of the subject are working on the life cycles of the digenetic trematodes, including studies on the further development of holostome, schistosome and stylet cercariae. Another group is studying the life cycles of tetraphyllidean cestodes. Other problems on the helminths are concerned with cestode and nematode morphology and with the life cycles of several nematodes in aquatic hosts. An interesting investigation on a blood-inhabiting protozoon, Leucocytozoon, is being carried out. Life history studies seem to

be best suited to the location and equipment of the Biological Station. The life cycles of a considerable number of parasitic forms have already been worked out and others are in the process of solution.

Attendance at the Station is a distinct advantage to the student. Students are constantly searching for appropriate problems for investigation, and many problems are being discovered at the Station as the biological situation there is more and more completely analyzed. The teachers of biology in the public schools are finding the Station to be a particularly valuable source of training for their work. A first hand knowledge of a large number of living things, both plant and animal, in their natural habitats and under normal conditions is of prime importance for doing the type of teaching required in the public schools. The usual college courses in biological subjects do not give this type of training. Two or three summers of attendance at the Biological Station give the desired training, and it stimulates an invaluable enthusiasm for biological work.

While the predominating spirit of the Station is one of work, the play side of life is by no means neglected. The entire Station population is brought together for meals in the large dining hall. Positions are reassigned by chance once each week so that the student population is constantly being shifted and new acquaintances are being formed. With the excellent water and an ideal sand beach and lake bottom, swimming is an attraction in the late afternoon. On the Fourth of July the annual picnic is held on top of a large hill overlooking the Station and lake. Here games and contests of various sorts are held, followed by a picnic supper, an initiation parade for the new students and a party or dance in the clubhouse in the evening.

On each Saturday night of the session an entertainment of some sort is given at the clubhouse. Bridge, stunt parties, "dress-up" parties, community singing, and dancing all have their turns. These attractions are very popular with the entire Station population, the only problem being that of room to accommodate the attendance.

During the summer several Sunday excursions are conducted to points of interest in this region. This summer on July 19 a group journeyed over the Michigan Inland Water Route starting at Conway and passing through Crooked Lake, Crooked River, Burt Lake, Indian River, and Mullet Lake to Topinabee, and return. On August 9 an excursion will visit historic Mackinac Island and Les Cheneaux Islands in Lake Huron. On August 16 the annual photographic exhibit is held at the Station. This is a display of any pictures of general interest which may have been taken by members of the Station, and opportunity is given for exchanges or purchases of prints.

Perhaps the feature event of the summer is the annual Visitors Day, which was held this year on the afternoon of August 2. On this date the Station held open house for the benefit of any visitors who wished to become acquainted with the Station and its work. The various buildings and laboratories are thrown open and samples of the class work and research are placed on display and qualified persons are present to explain or demonstrate each exhibit. This has come to be an interesting and enlightening attraction for people in this portion of the State, and the types of work are so varied and the number of workers is so great that, indeed, the members of the Station look upon this day as an opportunity to make themselves acquainted with the work done at the Station.

EXPERIMENTS ON THE AMPHIBIAN EGG

(Continued from Page 169)

operate on the egg, this shell must be taken off before cleavage begins; then the eggs are kept in the vitelline membrane up to the time of the operation.

When I began my experimental work, the scientific world was roused by that famous controversy between W. Roux on the one side, and H. Driesch and O. Hertwig on the other. W. Roux, in his classical pricking experiments on the frog's egg, had found that after killing one of the first two blastomeres with a hot needle, the other surviving cell would form half an embryo; from this he derived his conception of self-differentiation. H. Driesch, on the other hand, had stated that each of the first two blastomeres of the sea-urchin's egg, when separated, would form a whole embryo, half-sized, but normally proportioned. From this he derived his notion of the harmonic-equipotential system. O. Hertwig tried to separate the two first blastomeres of an amphibian egg, the egg of *Triton taeniatus*. He was not successful in this, but his method turned out to be of great importance.

My first experiment was to test Roux's results on the amphibian egg. Instead of killing one of the first two blastomeres, I tried to retain its development by means of low temperature. To do this I first constricted the eggs of Triton with a fine hair loop. I soon found that, in case of constriction along the median plane, either twins or

double monsters may be produced. Endres and Herlitzka had done the same thing a short time before me.

These experiments occupied me for several years. Their results did not at first go far beyond those which Driesch had found in the egg of the sea-urchin. I followed this author in testing the critical period of determination.

When an embryo of a somewhat later stage, for instance, with the tail bud just visible, is cut in two along the median plane, two half embryos will be formed; when the same is done in the two-cell stage, two whole embryos will develop. Between these two stages, there must be a critical point or a critical period in which the one way of development is turned into the other. I found that this period coincides with the period of gastrulation. The left and right halves of a very young gastrula will form whole embryos, more or less symmetrical. The more gastrulation proceeds, the greater is the defect on the inner side of the embryos; when gastrulation is finished, the axial organs can no longer be doubled. Later on, this experience led me to choose the early gastrula stage for my transplantation experiments.

Another series of experiments, those on the lens of the vertebrate eye, led me to the concept of induction. The single parts of the vertebrate eye develop, as you know, in close relation of space and time to one another. Just at the spot where the anlage of the retina, the primary eye-ball, touches the epidermis, and just in the moment it does do so, the lens is formed. Both processes seem to be connected as cause and effect. This may be tested by experiment. If the formation of the lens depends on some influence from the eye-ball, destruction of the latter should prevent formation of the former. In consequence the anlage of the eye-ball was eliminated, either early in the neurula stage, or later, after closure of the medullary folds. The effect is different in different amphibian genera. Nay even in different amphibian species. In *Rana temporaria*, a European frog, no lens was formed; Bombinator behaves in the same way. On the other hand, H. D. King found in an American frog, that lens formation may occur after destruction of the eye-ball; I could later confirm this in another European species of frog, *Rana esculenta*. The difference seems to be only a gradual one. Even Bombinator shows slight indication of lens formation. The same was observed by v. Ubisch in *Rana temporaria*.

Instead of elimination of the eye-ball, I suggested settling the question by bringing the eye-ball in contact with alien epidermis from other parts of the embryo. F. W. Lewis made this experiment by transplanting the eye-ball under the skin of the trunk. I later transplanted the skin on the eye-ball. These experiments, and many others performed since then, proved that the eye-ball may induce formation of a lens in parts of the epidermis that would normally not have formed one.

It is a fact of great theoretical importance that this faculty of inducing a lens in alien epidermis may be possessed by the eye-ball even of those species in which the lens may develop independently. Filatow showed this in the case of the epidermis of Bufo, brought in contact with the eye-ball of *Rana esculenta*. In this frog, as I showed, the lens may be formed after destruction of the eye-ball; yet this same eye-ball of *R. esculenta* was shown by Filatow to have the power of inducing a lens in the trunk epidermis of a toad's embryo. This was one of the first cases of what was called "principle of double insurance" by W. Rhumbler and H. Braus, a principle that has since turned out to be of great importance in development, and even in physiology. This concept means that there is a double factor of safety; as, for instance, when a bridge which is intended to carry one thousand people is built to carry two thousand. So, the lens might be formed without the eye-ball out of the proper region of the skin, yet the eye-ball has the faculty of forming lens out of perfectly indifferent skin. We will encounter this principle again in the normal formation and the experimental induction of the medullary plate.

The combination of these two series of experiments led me to the discovery of the "center of organization" and the "organizer." To make this quite clear, we must consider the first steps in the development of the amphibian egg.

The fertilized egg, as you know, is transformed, by segmentation into the blastula; the blastula, by invagination, into the gastrula. The outer layer of the gastrula, the ectoderm, is going to form in its dorsal part the medullary plate, the anlage of the central nervous system and of the eye-balls. If one marks a point of the ectoderm, near the animal pole, by staining it vitally, as W. Vogt did, one may find the mark just in the fore end of the medullary plate; the marked region has developed into medullary plate, it has been presumptive medullary plate. A second region of the gastrula, a little more in front, will form epidermis; it may be called presumptive epidermis.

Now the median constrictions proved that in the early gastrula stage the single regions cannot be determined, at least not irrevocably, as to their later fate; they must be able, at least to a certain degree, to fill out each other's place. It should be possible to test this by actually putting one in the other's place, that is by transplantation.

This may be done by means of fine instruments made of glass, namely by micropipettes, by glass rods drawn out to very fine points or by hair loops mounted on the capillary tip of glass tubes.

In this way presumptive medullary plate and presumptive epidermis of the early gastrula may be exchanged. They develop, not according to the old region they come from, but according to the new region into which they are brought; that is, presumptive medullary plate will form epidermis; presumptive epidermis, medullary plate. This may be seen clearly when the germs used for the experiment were of somewhat different color either by nature or by vital staining.

It is an important fact that such transplantations may be performed not only between germs of the same species (homoeoplastically); but also between those of different species (heteroplastically); for instance, between *Triton taeniatus* and *T. cristatus*. The eggs of the former species are more or less pigmented, while those of the latter are of a greenish white and almost free of pigment. In consequence, the transplanted pieces may be clearly distinguished, even in sections, throughout the early development. Here, too, the transplanted piece will adapt itself to its new surroundings; but in doing so, it will still retain its specific characteristics. Presumptive medullary plate of *T. taeniatus*, for instance, will form epidermis of the gills, when brought into the region of the presumptive gills in a gastrula of *cristatus;* but it will preserve the specific characters of the *taeniatus* epidermis of the gill region; the gills covered by it have the form of *taeniatus* gills of that early stage.

O. Mangold showed that presumptive epidermis may not only form medullary plate but almost anything else; somites, nephridia, intestine, etc.

However there is one region in the early gastrula the parts of which behave in a totally different way. If a piece of the upper lip of the blastopore or of its immediate surroundings is transplanted into the ventral side of a gastrula, it does not follow its new neighborhood in its development, but sticks to its own way. More than that, it forces its neighboring cells to follow it; it organizes its new surroundings and gives origin to a secondary embryo, partly built up by the cells of the implant, partly induced by them in the host's tissues. The chimaerical condition of such induced secondary embryos may be clearly demonstrated by heteroplastic transplantation, as Hilde Mangold has done in her beautiful experiments.

Because of this organizing faculty the region of the upper lip of the blastopore was called "center of organization," and the cells composing it, "organizers."

The next step in analyzing this center was to determine exactly its limits. This was done by H. Bautzmann. He found that all material of the dorsal and lateral lips of the blastopore will induce a medullary plate, which is invaginated during gastrulation to form the notochord and the mesoderm of the embryo. This was in full accord with a statement made a short time before in my laboratory by A. Marx, that the mesodermal roof of the archenteron has the power of induction. In both series of experiments the pieces of mesoderm were inserted into the coelom of a young gastrula through a slit in its upper part, and so came to lie, from the beginning, under the ectoderm of the embryo. This method was used in many of our later experiments.

These experiments were a starting-point for several lines of investigation which I have followed, together with an increasing number of young friends, during the last ten years. As the time is passing, I must restrict myself here to outlining briefly the most important results.

The first, almost perfect embryo induced by Hilde Mangold had a medullary tube without eyes, but with two ear vesicles, a notochord and two rows of somites. The secondary ear vesicles lay almost exactly in the same level with the primary ones. This suggested the question of the regional determination of the induced embryo. There might be a gradient of some sort, a head region and a trunk region either in the ectoderm or in the underlying mesoderm. If the latter were true, we might speak for the moment of a head organizer and a trunk organizer, words to which no deeper meaning is attributed. The head organizer would pass first around the upper lip of the blastopore, to be pushed forward to the region of the later brain, with its eyes in front and its ear vesicles on the posterior end. After this the trunk organizer would be invaginated, including that material that comes to lie under the medullary tube. In consequence, the upper lip of the blastopore of the gastrula just beginning to invaginate, consists of the head organizer, at the end of the gastrulation of the trunk organizer.

In view of this four series of experiments were made: (1) The head organizer was made to work on the head region, (2) The trunk organizer on the trunk region, (3) The head organizer on the trunk region, and (4) The trunk organizer on the head region. The result was that the head organizer always induces brain, with normal or with cyclopical eyes, either in the head or in the trunk region; the trunk organizer induces spinal chord without eyes and ear-vesicles in the trunk region, but it induces brain with eyes and ear-vesicles in the head region. From this the conclusion may be drawn that there is a gradient of some sort, or rather, as I think, some brain-forming factor

in the ectoderm as well as in the underlying mesoderm. Each of them is sufficient to warrant the formation of a brain; in normal development both work together to the same end. The fact that their effects are not cumulative seems to show that they are qualitative rather than quantitative.

One might feel inclined to assume that the whole development of the newt's egg is composed of single processes, one inducing the other. A good example would be the induction of the eye-anlage by the mesoderm, followed by the induction of the lens by the eye-ball. The latter, itself induced, goes on to induce; it might therefore be called a "secondary organizer" or an "organizer of second grade." Such a secondary organizer could be produced experimentally in the following way. A piece of ectoderm, presumptive epidermis or medullary plate was transplanted in the upper lip of the blastopore. It was invaginated together with the surrounding material and would have formed notochord. After invagination it was taken out again and transferred into the blastocele of another gastrula. Originally it would not have had the power of inducing a medullary plate; but in its new mesodermal surroundings it had apparently acquired this faculty; it induced a very beautiful medullary plate. It had become a "secondary organizer."

If this were of general occurrence, one might conclude that the whole development were purely epigenetical. But there are certain facts which will make us cautious. The lens, for instance, may be induced by the eye-ball; yet, in some species, at least, a lens may also originate without an eye-ball. The medullary plate might behave in the same way; though it can be induced by the underlying mesoderm, it might besides be able to originate without it. Recent experiments of Goerttler and especially of Holtfreter point in this direction; they show that presumptive medullary plate of the early gastrula, when isolated, may form nervous tissue. As it develops by self-differentiation, it must have been determined; but as the same material might have been induced to form epidermis, this determination cannot have been an irrevocable one. This case and other similar ones seem to justify the concept of "labile determination."

In normal development, presumptive medullary plate capable of self-differentiation, is in contact with mesoderm capable of induction—again a striking example of double insurance. One might speak of a "synergetical principle of development."

Little is known as yet about the structure of the center of organization and its means of inducing new structures. A rather radical way to test both is to destroy its structure and see what sort of an effect is left. Pieces of presumptive mesoderm were boiled, frozen, dried out, cut in very small pieces or pressed between a slide and cover glass. Only the mechanical methods have yielded positive results as yet. Organizers, finely chopped and mixed, or squeezed between glass slides, may induce a medullary plate. Besides that, they may exhibit a most wonderful power of self-regulation, which reminds one of the sponge experiments of H. V. Wilson. In two cases almost perfect embryos resulted, with medullary tube, notochord and two rows of somites. The medullary tubes were certainly induced. The mesodermal parts might have been induced; but most probably they were formed out of the implanted material itself.

Let me now, in conclusion, hint at some experiments which are just now going on in my laboratory. You remember the effect of heteroplastic transplantation: ectoderm of *Triton taeniatus*, transplanted into *Triton cristatus*, will adapt itself to its new surroundings and will form just the organs that are wanted in its new place; but it will form them in its own way, as *taeniatus*, not as *cristatus*. Now, if it were possible to combine in this way germs of different genera or even of different orders, as of an urodelan and an anuran amphibium, very interesting results might be expected. The larva of *Triton* has little teeth in its mouth, of a structure like other vertebrate teeth, while the tadpole has horny jaws. *Triton* has balancers below the eyes while the tadpole has suckers. Now, if ectoderm of a frog's gastrula is transplanted in the presumptive mouth region of the gastrula of a newt, what will be formed later? Will there be formed any part of the head armature at all and if so what sort? Teeth and balancers, or horny jaws and suckers? I can answer the question only for the latter organs, and even there only with a certain reserve. But I may say that just in the last days before my departure I saw beautiful suckers, in living specimens, in one case in sections, in the operated larvae of Dr. Schotté, with whom I am working on this problem. When these results have been worked out, they may throw some light on the nature of the stimulus that effects induction of organs. It is as if some key word were given: "mouth armature"; the response depends on the quality of the reacting material. But this way of looking at the things surpasses, at least for the moment, the limits of exact knowledge. It is my personal conviction that the processes going on in the living matter may be compared with nothing else so well as with the workings of our own mind. To deal with the living organism as if it were animated unto its last fibers, seems to me the best way to understand it and to help it.

That is all that I wish to tell you about my own experiments. But perhaps you will allow

me as a foreign guest to add a few personal words in conclusion. You will realize that a German who loves his country could not leave it lightheartedly just at the present moment. I would not have done it simply for my own pleasure. But I knew I was going to friends, and the welcome you have given my wife and myself has shown me that I was not mistaken. But I was welcomed by America even before I came to her shores, in a most wonderful way. In the reading room of our steamer, the "Europa," I saw in the four corners, four heroes of spirit, two German and two American, placed fraternally together: Kant and Goethe; Emerson and Walt Whitman. Few of us have studied Kant, but his spirit still pervades our life. Goethe is not dead amongst us; many of his works I know by heart. But besides Goethe, no authors of world literature have influenced me as much as Emerson and Whitman. If you were to look in my library, you would see that there are no books so well-thumbed as Emerson's *Essays* and the good grey poet's *Leaves of Grass*. When I think of them, I see two stars shining over your country; their names are freedom and comradeship. I wish to say to you that I feel happy under your stars.

THE FORMATION OF ICE CRYSTALS IN THE PROTOPLASM OF VARIOUS CELLS

Dr. Robert Chambers

Professor of Biology, Washington Square College, New York University

This past spring I had occasion to visit the Low Temperatures Station in Cambridge, England. The station, under the directorship of Sir William Hardy, has splendidly equipped laboratories, and in the basement are a dozen or more large rooms which can be maintained at various constant low temperatures. There I became interested in the question of what happens to protoplasm on freezing. At what temperature does freezing occur and what form do the ice crystals take within the cell? Do they form in such a way as to give one an inkling as to the existence of internal structure? In collaboration with one of the members of the Station, Mr. H. P. Hale, I started a series of experiments on muscle, amebae, and the epidermal cells of the red onion. These experiments were performed as follows: A muscle fiber of the sartorius of the frog was removed and placed in a dish of liquid paraffin, where it was passed back and forth several times to rid it of interstitial fluids. The fiber was then placed on a coverslip and inverted over the moist chamber of the micromanipulator which had been placed in a room of the desired temperature the night before. Fine thermocouples were used for determining the temperature of the hanging drop and the experiments were always performed in a room the temperature of which was several degrees lower than desired. By means of cold filters and by using a low power substage condenser, we were able to maintain fairly constant conditions in the drop. We worked mostly in a room the temperature of which was about—6°C. The drop could be warmed when desired by a fine loop of heated platinum. For the purpose of inoculating supercooled material we used a micropipette filled with water which was frozen so that a microcolumn of ice protruded through its tip. After the muscle fiber had been allowed to over-cool as it lay in the oil surrounded by a thin film of serum, the ice-tipped pipette was brought against the fiber, whereupon freezing took place. Fine flakes of ice spread over the surface of the fiber until the cut ends were reached. The ice at the cut ends initiated the formation of slender ice columns which ran in parallel linear lines along the interior of the fiber. The tips of the columns were pointed and they advanced regularly and progressively.

These experiments bring out two interesting points: (1) the ease with which the internal ice forms as slender columns running lengthwise within the muscle fiber. Apparently there is something which resists the formation of ice in the transverse but not in the longitudinal direction. This argues for the interior of the muscle fiber to consist of linearly arranged solid and liquid areas. The lower the temperature at which this internal freezing is brought about, the more rapidly grow these columns and the more slender and numerous they are. We also froze some fibers over the open top of a bottle containing liquid air. A photograph of such a fiber which had been accidentally broken across the middle, showed tiny columns projecting from the broken ends in the space caused by the break.

(2) The other interesting point about these experiments is the difference in temperature at which surface and internal freezing occurred. We obtained external freezing at about—1.8°C., but it was not until the temperature was lowered still more that we secured internal freezing. This is interesting because Mr. T. Moran of the Low Temperature Station, has found that muscle is irreversibly affected when frozen below a temperature of —1.5° to —2.0°. As the muscle was thawed, those fibers which had had columns of ice formed inside, contracted irreversibly, while the

fibers which had been frozen at the surface only, would be contractile at a temperature as low as —10°.

Our other experiments were on the ameba. Several organisms were placed in a drop of water on a coverslip. The drop was ringed with oil and as much water as possible drawn off, leaving the amebae flattened against the coverslip. A drop of oil was then deposited so as to touch the ring, and to enclose the amebae in a thin film of water. The coverslip was then inverted and brought to the low temperature. When the over-cooled water around the amebae was touched with the ice-tipped pipette, ice spread in several sheets from the site of seeding. On approaching the amebae the ice sheets grouped about them and spread until all of the water was frozen except for a narrow zone around the organisms. Freezing continued until finally this also was frozen. Occasionally the resulting compression was so great as to burst the amebae, whereupon they froze. Amebae which were not compressed sufficiently to cause bursting remained quiescent, with their pseudopodia extended and firmly embedded in ice. By raising a microneedle from below and pushing against the ameba, the granules within could be moved about. The temperature at which the culture-medium froze was in the neighborhood of —0.3°C. We had to drop the temperature considerably below this before we secured internal freezing of an intact ameba. This was done by inserting an ice-tipped pipette into the ameba, whereupon fine, feathery ice crystals would grow through the interior and stop inside the membrane. After a few minutes the crystals ran together into blocks of ice, squeezing the cytoplasmic granules into spaces between the blocks. It made a striking picture to observe amebae, as one after another was punctured. The unpunctured amebae were translucent and one could see the nucleus and contractile vacuole. Upon puncturing, the entire amebae at once became opaque. The ice crystals as they formed, could be seen to run around the contractile vacuole, and then after a bit this, too, would freeze.

We obtained analogous results with plant cells. Strips of the epidermis of the common red onion were placed in liquid paraffin and frozen by touching with an ice-tipped pipette. Freezing of the escaped sap first occurred over the surface of the strip and then in the cavities of the dead cells. Ice crystals would form under the cellulose wall of normal appearing cells, resulting in a diminution of the vacuole. The protoplasm progressively shrank as the color of the contained sap became intensified, suggesting the extraction of water. On thawing, the water was reabsorbed. In other words, with freezing it is possible to obtain reversible plasmolysis. At temperatures between —8° C. and —10° C. spontaneous freezing of the sap within the vacuole may occur, but above —8° C. freezing of the sap occurred only when the protoplasm had ruptured. This suggests that plant cells, as well as the ameba and the muscle fiber, possess a membrane which can prevent external freezing from inoculating the interior. In the case of the ameba and of the muscle fiber, it is of interest to note that the type of crystal formation within the former denotes a lack of definite structure, while the reverse is true for the latter.

Discussion

Question: I wonder if these results are not similar to what you get in fine capillaries where there is supercooling and then a small crystal of ice is added? At 5° or 6° below zero the whole thing solidifies.

Dr. Chambers: It is true that the capillary dimensions of the droplets I used made it far easier to induce supercooling than if the fluids used had been in greater amounts.

Question: As I understand it, the ice crystals did not form, at least in muscle cells, unless they came in from the outside. You had no formation of ice crystals inside when the membrane was intact?

Dr. Chambers: Occasionally we obtained spontaneous freezing of a cell but that was only when the temperature was considerably below the freezing point of the interior. However, at a temperature at which external freezing occurred no internal freezing could be induced even when a piece of ice was inserted into the interior. At a temperature still lower, seeding the interior induced internal freezing.

Question: When you had actually penetrated the membrane, did the ice columns proceed strictly longitudinally, or did they ever extend transversely?

Dr. Chambers: If the seeding occurred at the cut end of a fiber, the ice columns started at that spot and advanced in parallel, longitudinal lines along the interior of the fiber. If the seeding occurred at a tear in the sarcolemma on the side of the fiber, the columns started at this spot and sprayed out in curves from there, then running along in the two longitudinal directions to the two ends of the fiber.

Question: Would you draw the conclusion that outside freezing does not extend through to the inside? How would you interpret this as relating to the pore theory?

Dr. Chambers: The surface of the cell apparently serves as a barrier against seeding of the interior from the outside. I do not know whether a pored membrane would act in a similar manner.

Question: Is anything known about the be-

havior of artificial membranes? Will freezing pass through them?

Dr. Chambers: Blocks of gelatin will freeze if the temperature is lowered sufficiently. At a relatively high temperature there will be surface freezing, extraction of water, and shrinking of the gelatin. By lowering the temperature the freezing will spread into the gelatin block.

Comment: It seems to me that it would be a good thing to make experiments with membranes having pores of known sizes. I do not believe the gelatin membrane would help much because we know that that is mostly water. A dried collodion membrane, for instance, is extremely permeable. If it should turn out that freezing would or would not go through a collodion membrane, it might throw a great deal of light on the question.

Question: How do you interpret the longitudinal spread of freezing with reference to the internal structure of the fiber?

Dr. Chambers: The myofibrils are longitudinally arranged, solid elements, immersed in a more fluid medium; and the whole is surrounded by a membrane which resists the inoculation of freezing from without.

Question: Did the ameba show reversal, and the muscle fiber also?

Dr. Chambers: None of the amebae we observed showed recovery from internal freezing. They were irreversibly coagulated. Unfrozen amebae, kept in solid ice at—3°C. for 3 hours, may recover on thawing. When an internally frozen muscle-fiber was thawed an irreversible shortening always took place.

SCIENTIFIC BOOK REVIEWS

The Laboratory Mouse. Its Origin, Heredity and Culture. Clyde E. Keeler, 81 pp. Harvard University Press. 1931.

A brief statement of the geographical distribution of the mouse is followed by an informing account of the antiquity of the fancy mouse. It appears that dominant spotting, albinism, and waltzing were all recorded before the present era. The other breeds were distinguished much later. Since in the classical literature the same word *Mus* was used for both the mouse and the rat, it is only possible to determine which is meant by the help of indirect evidence.

Some twenty-four breeds of mice are briefly described and these descriptions followed by a useful table, listing for twenty-seven varieties the fanciers' term, the scientific term and the genetic formula.

The genetics of normal and abnormal inheritance are then considered, and the book closes with a chapter on the laboratory breeding and care of these animals.

Twenty-one life-size figures, in black and white, indicate the habit and coat color in the several breeds. —H. H. DONALDSON.

Laboratory Studies in Zoology. H. D Reed and B. P. Young. 1930. viii plus 121 pp. McGraw-Hill Book Company.

This laboratory manual has grown out of the elementary course in zoology at Cornell. Approximately half the book is devoted to outlines for the study of the frog. Keys are given for student identification of Protozoa and for "the larger groups of animals." This adds another to the distinctly teachable laboratory outlines in elementary zoology for the increasing number of teachers who dislike to "roll-their-own"

—W. C. ALLEE.

The Genetics of Domestic Rabbits. A Manual for Students of Mammalian Genetics and an Aid to Rabbit Breeders and Fur Farmers. W. E. Castle. 31 pp. 39 figs. Harvard University Press. 1930.

This brochure is a pendant to Castle's larger book on genetics. It deals only with the rabbit and its immediate purpose is indicated in the subtitle.

Twelve mutations are precisely described in four groups under: "Color Mutation," "Spotted Coat," "Structure of Coat" and "Color of Fat." The genetic constitution of each of the various breeds is given in detail. There follows a chapter on body size and ear length The figures are ercellent and the book forms a handy compendium for those concerned with the rabbit in any way.

—H. H. DONALDSON.

Textbook of Histology. Eugene C. Piette, M. D. 450 pp. 1931. F. A. Davis Company.

This elementary text is made short and simple to meet needs of medical and dental classes, but merits wider usage. The style is crisp, the 277 illustrations are admirably chosen and spaced. Key words and phrases on every page are set in bold face type to save the student time in reviewing. There is more material of general biological interest than in many medical texts, and an effort has been made to include recent work in the various fields. Histological techniques are briefly and neatly described in an introductory chapter. Forty pages are given over to cytology, a hundred and fifteen to general histology, and the rest to special histology.

In common with so many American scientific books, this text is printed on glossy paper. Glossy paper was invented by the devil to blind the eyes of those who read at night. —W. W. BALLARD.

THE DIRECTORY FOR 1931

(ADDITIONS)

This list contains the names of the workers at the laboratories in Woods Hole which were not included in the first number of THE COLLECTING NET.

KEY

Laboratories		Residence	
Botany Building	Bot	Apartment	A
Brick Building	Br	Dormitory	D
Fisheries Laboratory	FL	Drew House	Dr
Lecture Hall	L	Fisheries Residence	F
Main Room in Fisheries Laboratory	M	Homestead	Ho
Old Main Building	OM	Hubbard	H
Rockefeller Building	Rock	Kidder	K
		Whitman	W

In the case of those individuals not living on laboratory property, the name of the landlord and the street are given. In the case of individuals living outside of Woods Hole, the place of residence is in parentheses.

THE MARINE BIOLOGICAL LABORATORY

Investigators

Alderman, Evangeline grad. asst. Wellesley. Br 204. W a.

Anderson, R. S. res. assoc. Princeton. Br 110. McInnes, Millfield.

Ashkenaz, D. M. asst. biol. New York. Br 328. Cavanaugh, High.

Atlas, M. asst. emb. Columbia. Br 314. Dr 14.

Austin, Mary L. asst. prof. zool. Br 217B. Nickerson, Quissett.

Bakwin, H. asst. prof. pediatrics New York. OM 38. Tinkham, Gardiner.

Bakwin, Ruth instr. pediatrics New York. OM 38. Tinkham, Gardiner.

Ball, E. G. instr. phys. chem. Hopkins Med. Br 110. Veeder, West.

Beck, L. V. grad. asst. phys. New York. Phys. Lab. McLeish, Millfield.

Beutner, R. prof. pharmacology, Louisville Med. Br 325. Lewis, Buzzards Bay.

Biddle, R. asst. gen. Col. Inst. Tech.

Borodin, D. N. invest. plant phys. Yonkers, N. Y. Bot. Hilton, Millfield.

Buck, Louise H. asst. cytol. New York. Br 343. D 105

Butt, C. res. asst. Princeton. Br 116. Sylvia, Millfield.

Carabelli, A. A. med. stud. Pennsylvania. Br 114. Addison, Gosnold.

Carlson, J. G. instr. biol. Bryn Mawr. OM 33. K7.

Castle, W. A. instr. biol. Brown. Br 233. Kittila, Bar Neck.

Chor, H. neurol. Washington Med. (St. Louis) Br 223. (Falmouth).

Clark, Frances M. Lilly Res. Labs. Br 328B. Howes, Main.

Coldwater, G. instr. zool. Missouri. Br 335.

Corey, H. Irene res. asst. Pennsylvania. Br 219. Purdham, Main.

Cowles, R. P. prof. zool. Hopkins. Br 336. D 101.

Curtis, W. C. prof. zool. Missouri. Br 335. Dr 211.

Dearing, W. H. grad. cytol. Pennsylvania Med. Br 220. Elliot, Center.

Dunbar, F. F. grad. asst. zool. Columbia. Br 333. Wallace (Falmouth).

Eastlick, H. L. grad. asst. zool. Washington (St. Louis) OM Base. Dr. 7.

Einarson, L. res. fel. Harvard Med. Br 108. A 107.

Eyre, Sara W. res. asst. Long Island. OM 45. D 209.

Favilli, G. asst. Inst. of Gen. Pathology, Royal (Florence, Italy) Br 208. Elliot, Center.

Francis, Dorothy res. asst. Memorial Hosp. (N. Y.) Br 329. W f.

Fraser, Doris A. asst. anat. Pennsylvania Med. Br 114. Addison, Gosnold.

Gayet, D. dir. Lab. Physiologie Pathologique (Paris) Br 109. Broderick, North.

Graham, C. H. Nat. Res. fel. Pennsylvania Br 231. Hilton, Main.

Green, Arda A. res. fel. phys. chem. Harvard Med. Br 108. Grinnell, West.

Greenwood, A. W. lect. Inst. Genetics (Edinburgh) Br 123.

Hartline, H. K. fel. med. physics Pennsylvania. Br 231. McLeish, Millfield.

Hitschler, W. J. grad. Pennsylvania. Br 117. Wilde, Gardiner.

Hodge, C. Jr. instr. zool. Virginia. Rock. Rohmeling, Pleasant.

Hodge, Ruth P. grad. bot. Virginia. Bot. Rohmeling, Pleasant.

Heiss, Elizabeth M. grad. asst. biol. Purdue. Phys. Lab. W g.

Jackson, J. P. grad. asst. bot. Missouri. Bot. Dr 2.

Johnson, H. H. Col. City N. Y. Br 315. White, Millfield.

Jones, N. scientific artist. Br. 211. A 201.

Kille, F. R. assoc. prof. biol. Birmingham Southern. OM Base. D 307.

Kostir, W. J. asst. prof. zool. Ohio State. Bot 6. Gifford, Juniper Point.

Lambert, Elizabeth F. tech, phys. Harvard Med. Br 107. Young, West.

Lewis, I. prof. bot. Bot. Virginia, Hubbard, East.

Loebel, R. O. Russell Sage fel. Cornell Med. Br 340. Nickerson, Church.

Margolin, S. grad. proto. Columbia. Br 314. Avery, Main.

Metcalf, M. M. res. assoc. zool. Johns Hopkins, High.

Moor, Carmen, Sec. to Dr. Bronfenbrenner. Gifford, Juniper Point.

Moor, W. A. tech. bact. Washington (St. Louis) Br 2 Gifford, Juniper Point.

Morris, Helen grad. Columbia. Bot. McInnis. Millfield.

Nelsen, O. E. instr. zool. Pennsylvania. OM 21. K 9.

Nicoll, P. A. grad. zool. Washington (St. Louis) OM Base. Dr. 7.

Oltmann, Clara Columbia. OM 34. W h.

Reznikoff, P. instr. med. Cornell Med. Br 340. McKenzie, Pleasant.

Risley, P. L. instr. zool. Michigan. L 21. Gifford, Juniper Point.

Rugh, R. instr. zool. Hunter. Br 217M. D 303.

Schauffler, W. G. physician. Princeton. L 24. Fish, Woods Hole.

Schmidt, Ida Genther jr. res. fel. Children's Hosp. (Cincinnati) Br 110. Neal, Woods Hole.

Schmuck, Louise grad. cytol. Johns Hopkins. Br 343. H 2.

Schuett, J. F. zool. Chicago. Br 332. North.
Scott, Florence M. asst. prof. biol. Seton Hall. Br 217D. Nickerson, Millfield.
Shore, Agnes instr. chem. Bellevue Med. (New York) Br 310. A 206.
Sickles, Grace asst. bact. N. Y. State Dept. Health. Br 122. Young, West.
Smith, Suzanne Instr. zool. Missouri. Br 335. Erskine. Woods Hole.
Snyder, C. D. prof. phys. Hopkins Med. Library, McKenzie, Pleasant.
Spemann, H. dir. Zool. Inst. (Freiburg) Br 306.
Steinbach, H. B. grad. zool. Pennsylvania. Br 220. Elliot, Center.
Stewart, Dorothy R. asst. prof. biol. Skidmore. Br 222. White, Millfield.
Stokes, Julia C. res. asst. Washington Med. (St. Louis) Br 2. Hamilton, Main.
Taft, C. H. Jr. assoc. prof. pharmacology Texas Med. L 32. Whitman.
Tocker, A. J. res. asst. bacteriol. Washington Med. (St. Louis) Br 2. Dinsmore, School.
Tohyama, G. asst. prof. Tokio Imperial. L 31. Cahoon, Main.
Turner, J. P. instr. zool. Minnesota. Br 217n. Grinnell, West.
Tyler, A. instr. emb. California Inst. Tech. Br 315. Goffin, Millfield.
Tyler, Betty S. res. asst. emb. California Inst. Tech. Br 315. Goffin, Millfield.
Walker, P. A. grad. Bowdoin. OM 41. Thompson, Main.
White, Edna tech. Hopkins. Br 343. Moses, Agassiz.
Wolf, E. A. asst. prof. zool. Pittsburgh. OM 43. Elliot, Center.

U. S. BUREAU OF FISHERIES

Investigators

Cobb, Margaret V. res. assoc. Education. Harvard. M. Howes, Main.
Hooker, C. W. grad. zool. Duke. FL 54. F 149.
Long, Margaret E. tech. Duke. FL 149. Lewis, High.
Parr, A. E. asst. prof. zool. Yale. FL 141. F 2.

OCEANOGRAPHIC INSTITUTION

Bigelow, Elizabeth 109. Luscombe, Main.
Borodin, N. A. Museum Comp. Zool. (Cambridge) 107. Lewis, Buzzards Bay.
Lambert, Anne 105. Young, West.
Redfield, A. C. prof. phys. Harvard. 103. Price, Church.

INVERTEBRATE ZOOLOGY

Instruction Staff

Bissonnette, T. H. prof. biol. Trinity. OM 26. D 108-109.
Cole, E. C. assoc. prof. biol. Williams. OMB 24. D 304.
Coonfield, B. R. instr. zool. Brooklyn. OM 29 D 306.
Dawson, J. A. asst. prof. biol. Col. City N. Y. OM 28. A 302.
Hadley, C. E. asst. prof. biol. N. J. State Teachers' (Montclair) OM 32. Hilton, Main.
Nelson, O. E. instr. zool. Pennsylvania. OM 21. K 9.
Parks, Elizabeth K. grad. asst. Oberlin. OM. W d.
Pollister, A. W. instr. zool. Columbia. OM 44. D 314.
Sayles, L. P. instr. biol. Col. City N. Y. OM 25. D 214.
Severinghaus, A. E. asst. prof. anat. Columbia. OM 31. K 12.

Students

Aguayo, C. G. asst. prof. biol. Havana. Clough, Millfield.
Anthony, Elizabeth S. grad. Brown. H 7a.
Bachrach, Josephine E. Vassar. Grinnell, West.
Baker, E. G. S. stud. asst. anat. and emb. De Pauw. K 6.
Barron, D. H. asst. Yale. Cowey, Depot.
Belcher, Jane C. Colby. Cowey, Depot.
Brewster, J. R. ed. Univ. Film Found. Avery, Main.
Chase, H. Y. grad. Howard. Dr 8.
Chen, H. Harvard. Dr 9.
Chinn, M. Priscilla grad. Goucher. Cowey, Depot.
Clark, Adele F. Tufts. Kittila, Bar Neck.
Clark, Jean McN. Wilson. Hilton, Main.
Clausen, R. G. instr. biol. Union. Smith, Glendon.
Cohen, B. M. asst zool. Johns Hopkins. Nickerson, Millfield.
Corey, H. Irene res. asst. Pennsylvania. Purdham, Main.
Croley, J. T. Dartmouth. Dr.
Dimick, Helen Wellesley. H 7.
Drew, R. W. Wesleyan. K 5.
Drugg, Helen Vermont. Sanderson, High.
Eastlick, H. L. grad. asst. zool. Washington (St. Louis) Dr 7.
Ellis, Lola M. asst. biol. Southwestern. W c.
Fish, H. S. grad. Harvard. Crowell, Main.
Forhan, Laura Montana, Broderick, North.
Fuchs, B. American (Washington, D. C.) Dr attic.
Gerstell, R. Dartmouth. Dr 1.
Glidden, Dorothy P. grad. Smith. W e.
Hegner, Isabel Radcliffe. Conklin, High.
Hetrick, L. A. Jr. asst. biol. American (Washington, D. C.) Dr. 3.
Howard, J. W. Hamilton. K 8.
Hussey, Kathleen L. fel. zool. Ohio Wesleyan. W c.
Jefferson, Margaret D. Pennsylvania Col. for Women Broderick, North.
Johnson, Arlene C. Wheaton. H 6.
Jones, E. R. lect. biol. Dalhousie. (Halifax) K 8.
Kilgore, B. Butler. Robinson, Quissett.
Kramer, T. C. res. asst. biol. Western Reserve. K 7.
Langstroth, Muriel A. Dalhousie (Halifax) Gray, Buzzards Bay.
Mann, D. R. grad. asst. zool. Duke. Hall, Millfield.
Melvin, G. grad. De Pauw. K 7.
Metzner, J. fel. zool. Col. City N. Y. Young, West.
Moment, G. B. fel. zool. Yale. Cowey, Depot.
Nicoll, P. A. Washington (St. Louis) Dr 7.
Pomerat, C. A. asst. biol. Clark (Worcester) Higgins, Depot.
Raye, W. H. Jr. Amherst. Dr 6.
Rosenbaum, Louise lab. asst. zool. Pennsylvania. Sanderson, High.
Rountree, Katherine E. instr. biol. Wesleyan. W b.
Sanders, R. grad. Yale. White, Millfield.
Smith, O. R. grad. Cornell. Supply House.
Solberg, A. N. instr. zool. North Dakota Agricultural. Avery, Main.
Stewart, P. A. Rochester, K 6.
Thomas, T. B. grad. asst. Oberlin K 5.
Warters, Mary asst. prof. biol. Centenary (Shreveport, La.) K 2.
Westkaemper, Remberta instr. biol. St. Benedict. Nickerson, Millfield.
Willard, W. R. Yale Med. Dr 2.
Wismer, Virginia asst. bot. Pennsylvania. Sanderson, High.
Young, D. G. Acadia. McLeish, Millfield.

The Collecting Net

A weekly publication devoted to the scientific work at Woods Hole.

WOODS HOLE, MASS.

Ware Cattell .... Editor

Assistant Editors

Margaret S. Griffin Mary Eleanor Brown

Annaleida S. Cattell

EDITORIAL NOTES

Three more numbers of THE COLLECTING NET will be published this season, the last one being issued on Saturday, August 29. Material for publication in this issue cannot be accepted after Monday, August 24.

The plan of selling books to obtain money for THE COLLECTING NET Scholarship Fund has been a successful one. A sum of over one hundred dollars has already been realized from this source. We still have a large collection of books for sale at reduced prices. Books on Cape Cod and a few of the current magazines can be purchased at the publisher's list price. We are under obligations to Miss Ruth Ann Johlin for the poster of the darky holding the announcement of our sale.

Several young biologists who would like to obtain positions this winter have placed information about themselves on file in our office. This is available for consultation by individuals who might be concerned with their appointment.

PICNIC PARTIES ON NAUSHON AND NONAMESSET

The following statement has recently been received by the Marine Biological Laboratory from Mr. Ralph E. Forbes, Managing Trustee of the Forbes Estate:

The Trustees of Naushon have had under consideration the matter of permitting the landing of picnic parties at different parts of their property and they have decided to modify the regulations which have been in force for some years.

On account of the building of two new houses by members of the family, one on Nonamesset overlooking Inner Hadley Harbor and one on Goat's Neck, it has been decided to cancel the general permission given to the public to land on the so-called Wild Duck Wharf on Goat's Neck and in the stead thereof, to authorize the landing of picnic parties on the white sand beach on the North side of Nonamesset near the old Nonamesset House; and the other point where picnic parties may land is the small Cove which faces South on the Sound at the extreme Eastern point of Nonamesset; and on the island of Naushon, permission is given the public to land on the white sand beach at Tarpaulin Cove, but with this proviso in both cases,—that picnic parties of more than twenty-five persons are requested to notify Mr. Allan the foreman at Naushon Farm and obtain from him the permission of the trustees for landing such large parties.

The lighting of fires without permission, on any land of the Naushon Trustees, is prohibited.

We wish at this time to express our appreciation of the consideration which has been shown by the members and students of your school, in clearing up the traces of their picnic parties in the past. Other picnic parties have frequently been less considerate and we find it important to make more strict rules than in the past.

Will you kindly inform those who wish to land and make use of the privileges of Naushon and Nonamesset, of the new regulations which we are putting in force?

DR. FRY AND THE FORTY DROSOPHILA EGGS

DR. ALFRED F. HUETTNER

Professor of Biology, Washington Square College, New York University

In his review of my recent seminar report Dr. Fry criticized my observations on the Drosophila egg by comparing my data with his own which he obtained from forty Drosophila eggs. He found that only half of this number of segmenting eggs showed centrioles during interkinesis, and the reader is left with the impression that I must have had similar results and that I must have withheld such negative evidence in my recent report.

I have studied thousands of Drosophila eggs, and I have coagulated them with a large variety of fixing agents, beginning with Weismann's heat coagulation and ending with the specialized techniques of Mottier and Kopsch. Invariably all segmenting Drosophila eggs show centrioles during interkinesis when coagulated with the standard fixing agents commonly used in cytologic technique, and I am willing to demonstrate this fact to anyone who is interested in this problem.

—ALFRED F. HUETTNER.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the hole turns to run from Buzzards Bay to Vineyard Sound:

Date	A. M.	P. M.
Aug. 9	12:55	1:10
Aug. 10	1:52	2:03
Aug. 11	2:43	2:51
Aug. 12	3:33	3:48
Aug. 13	4:21	4:34
Aug. 14	5:10	5:24
Aug. 15	6:01	6:19
Aug. 16	6:44	7:05
Aug. 17	7:36	8:00
Aug. 18	8:23	8:28

ITEMS OF INTEREST

SCRIPPS INSTITUTION OF OCEANOGRAPHY

Mr. R. D. Norton, Palaeontologist of the Texas Company, Shreveport, Louisiana, visited the Institution last week to consult Director T. Wayland Vaughan concerning certain problems of foraminifera and marine sediments.

Dr. F. S. Brackett, Chief of the new Division of Radiation and Organisms of the Smithsonian Institution of Washington, delivered a lecture at tht Scripps Institution on Wednesday afternoon of last week. His subject was "Study of the effect of radiation on plants," and he devoted considerable time to explanation of methods of investigation being developed by his Division. He showed that already they have obtained remarkably accurate measurements of the use of light by a plant both in respect to the common rays of "white light" and in respect to the color components (red, blue, ultra violet, etc.) of such rays. He was accompanied by Prof. A. R. Davis of the Department of Plant Physiology of the University of California at Berkeley.

Mr. H. B. Foster, Engineer of the Comptroller's office of the University of California at Berkeley, visited the Institution on University business from Saturday of last week to Tuesday of this week.

On Wednesday evening of this week Prof. W. P. Kelley of the Department of Agricultural Chemistry in the Citrus Experiment Station at Riverside delivered a lecture on "Base exchange in soils." This lecture was especially interesting to members of the scientific staff of the Institution because a number of the problems discussed are similar to those encountered in study of marine sediments.

Mr. and Mrs. James Leach, Teaching Fellows in the Departments of Zoology and Palaeontology, respectively, of the University of California at Berkeley, were week-end guests of Mr. and Mrs. E. H. Myers.

On Saturday of last week Mr. Harry Reddick, City Engineer of Santa Paula, arrived by aeroplane to spend the week end with his cousin, Mr. L. D. Barber, Superintendent of Construction at the Institution.

On Monday evening, August 3, at 8:00 p.m., Dr. F. B. Sumner will deliver a lecture in the Institution library entitled "Some results of seventeen years study of geographic races of mice."

MT. DESERT ISLAND BIOLOGICAL LABORATORY

Dr. and Mrs. C. C. Plitt of the University of Maryland arrived August 4th, 1931. They will be at the Laboratory for the rest of the summer.

Mrs. William H. Cole arrived August 1st. Dr. Cole is working at the Laboratory this summer.

Dr. and Mrs. A. Mansfield Clarke of The Johns Hopkins Medical School visited Dr. and Mrs. Warren H. Lewis over the week-end.

The Monday evening seminar on August 3rd will be in charge of Dr. H. D. Senior of New York University who will speak on "The radical difference between the arterial anomalies of the human upper and lower extremities.", and Dr. A. Defrise of the University of Milan, whose subject is "Sytophysiology of Kidney."

Miss Miriam F. Clarke who is now a student in the Department of Biochemistry at Yale Medical School, has been visiting her brother, Mr. Robert Clarke for a few days.

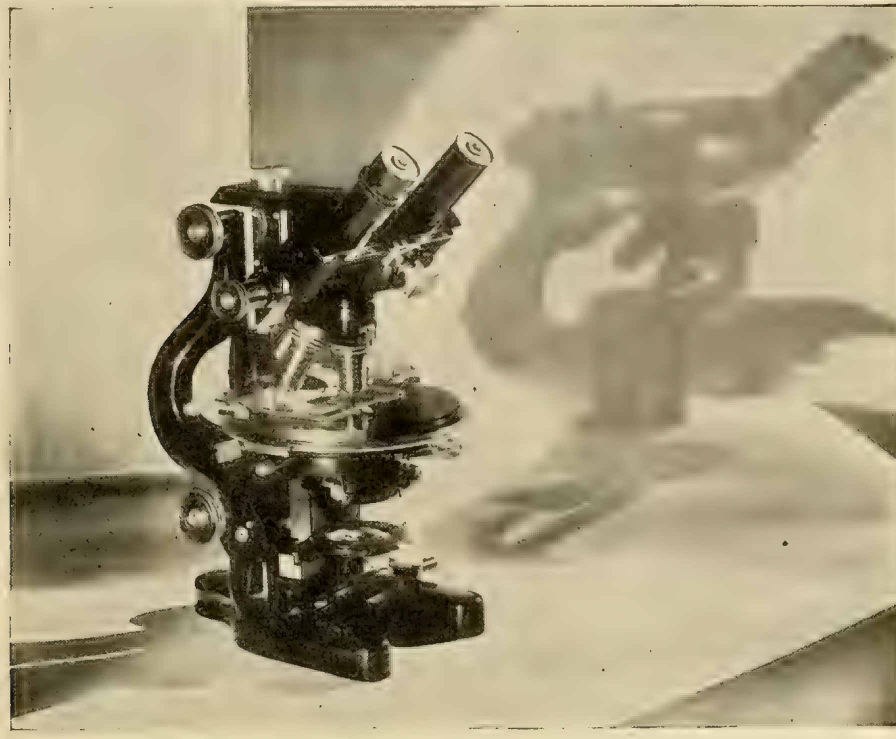
Dr. and Mrs. William Wherry entertained the members of the Laboratory at a barn dance on August 1st. Prizes for the best costumes were won by Dr. Esther F. Byrnes and her sister, Miss Byrnes, who appeared as bugs; Mrs. W. L. Holt, Jr., who dressed as a mummy; Dr. Homer W. Smith, as an organ-grinder; Miss Frances Snow, as an old-fashioned lady; Mr. William L. Doyle as a pirate; Mrs. E. K. Marshall, Jr., as a little girl. Miss Louise Mast and Mr. Heinz Specht were given a prize for the dirtiest costumes. Prizes were also given to the Misses Louise and Elizabeth Mast and Mr. Robert F. Mathews for stunts. —Louise R. Mast.

Miss Louise Schmuck and Dr. Helen Smith have returned to work in Dr. Metz's laboratory after a month's vacation. They were guests of the Right Reverend Mr. and Mrs. Schmuck in Laramie, Wyoming, and motored with them to Yellowstone National Park and other western points of interest.

The M. B. L. Club has announced the two following programs for this week's victrola concerts: Sunday, August 9:—8:00 P. M. Egmont Overture, Beethoven; Rosamunde Ballet Music, Schubert; L'Apres-midi d'un Faune, Debussy; Symphony No. 5, Beethoven.

Thursday August 13 — 8:00 P. M. Clarinet Quintet, Brahms; Passacaglia, Bach; Quartet, opus 135, Beethoven.

The music begins promptly at 8:00 P. M.



THE WOODS HOLE LOG

On Tuesday, August 4th Coast Guard Base 18 at Woods Hole celebrated its 143rd birthday. The Base was open to the public during the day and many members of the Laboratory, as well as others, visited the Base and were shown over the patrol boats by a member of the Coast Guard. The boats were gaily decorated with flags. A water sports program was held in the morning; in the afternoon the Base 18 baseball team played a team from the Coast Guard cutter, "The Acushnet;" and in the evening a dance was held in the Community House.

Traffic must be slow both under and over the drawbridge on Main Street. Captain John J. Veeder, harbor master, has had signs placed at the entrance to the Eel Pond limiting the speed of boats to five miles per hour. The wash of swift boats is threatening to undermine the bridge while heavy trucks rolling over it cause a vibration that is also weakening it. The word "slow" has been painted in large yellow letters on the surface of Main Street at the approach to the bridge and signs have been posted setting the speed limit for cars at ten miles per hour.

Heavy frosts this past winter have also weakened the bridge, cracking pieces of the counter balance weight and making it lighter, necessitating the addition of two thousand pounds of pig iron to the balance weight. This, and the gates for keeping back traffic when the draw is open, represent part of the improvements provided by the $3100 appropriation voted for the bridge in town meeting this year.

On Friday afternoon, July 31st, Old Ironsides passed by in full view of Woods Hole harbor. From then until Thursday of this week, she has made New Bedford her port and people have poured from all over the Cape to see the historic old frigate. On Sunday 11,906 people visited her and several hundred were turned away from the gangplank as the crew closed the ship for the day.

On July 31st, Mr. Inglis Moore Uppercu of New York City president of the Uppercu Cadillac Corporation, sailed into Great Harbor in his square-rigged sailing vessel, "The Seven Seas." He anchored for the night and sailed the following morning for New York.

The Y. P. L. Girls of the Methodist Episcopal Church are giving a picnic to the children of the Sunday School and their parents at Old Silver Beach next Wednesday afternoon.

The annual flower show of the Cape Cod Horticultural Society will be held this year in Falmouth on August 12, 13 and 14th on the Village Green.

The University Players Theatre this week was turned into a courtroom when the case of the People against Mary Dugan came up for trial. At 8:15 the cleaning women and the court attendants began to get ready for the big case and at 8:30 the court convened.

Bayard Veiller's dramatic recording of "The Trial of Mary Dugan" is good theatre. The cast is very large and yet each person in the cast is a distinct character. There are fine chances for dramatic interpretation even in the most minor parts. The Players did a good piece of work. Notably Bretaigne Windust, as District Attorney Galway, left nothing to be desired. From the moment when he presented the case to the jury-audience he was lawyer through and through and, in a way, he it was who held the whole play together and was responsible in large measure for its success. Two other parts were completely satisfying. Elizabeth Fenner as the murdered man's wife and Christine Ramsey as Marie, her voluble French maid.

The Players were attempting a tremendous feat this week. They played under a handicap in following so closely on the heels of a Broadway production which was pretty nearly perfect and they must pay the penalty for this by having the audience, of necessity, make comparisons. Cynthia Rogers as Mary Dugan was good but there was something lacking in her rendition. You could forget, as she sat quietly listening to the testimony of witnesses, that she was a kept-woman on trial for her life for the murder of her lover. Even on the witness stand the moments were rare when she made the audience feel her struggle as a girl of fourteen to bring up a young brother and her solution of financial worry by becoming mistress to a wealthy man. There were times when she succeeded in projecting this stage personality across the footlights but her character was not sustained throughout the performance. Henry Fonda as her younger brother, Jimmy, who took over his sister's case as lawyer, was more satisfactory, though he didn't look as boyish as the role requires.

The minor parts were excellently characterized throughout. The stage was much enlarged and the set effective.

Next week Elizabeth Fenner and Kent Smith will take the parts played in New York by Lynn Fontanne and Alfred Lunt in the production of Ferenc Molnar's satire on the home life of an actor, "The Guardsman." —M. S. G.

THE COLLECTING NET

Vol. VI. No. 8. SATURDAY. AUGUST 15, 1930 Annual Subscription, $2.00 Single Copies, 25 Cts.

IS THE PERMEABILITY OF THE ERYTHROCYTE TO WATER DECREASED BY NARCOTICS?

Drs. M. H. Jacobs and A. K. Parpart

University of Pennsylvania

Among the evidence commonly cited in support of the theory that narcosis is associated with a decreased cellular permeability is the fact observed by Arrhenius and Bubanovic, Jarisch and others, that narcotic agents, such as ether, chloroform, various alcohols and urethanes, etc. tend in certain concentrations to oppose osmotic hemolysis. This result has been interpreted as indicating a lowered permeability of the cell to water in the presence of narcotic agents. An examination of the data published by the workers in question, however, shows that no clear distinction was made by them between the degree of hemolysis ultimately attained, which probably has little to do with permeability to water, and the *rate* at which the final equilibrium position of the system was reached, which conceivably may have some such connection. (*Continued on Page* 201)

THE MARINE ZOOLOGICAL LABORATORY AT THE ISLES OF SHOALS

Dr. C. F. Jackson

Director of the Laboratory

The Isles of Shoals are a group of eight rocky islands lying about ten miles out from Portsmouth, New Hampshire. They are of varying size, the largest being about a mile in length while the smallest is scarcely a few hundred yards across.

Very little is known of the early history of the Isles of Shoals. Before the appearance of the white settlers, it is quite possible that the Indians may have used the islands as a fishing place; coming thither in canoes and camping until the season's catch was sufficient to meet their needs. Champlain and de Monts may have seen the islands in 1605 during their exploration of the New England coast. Captain John Smith gave them his name in 1614, and when members of his expedition proposed to divide his discoveries, he describes the islands thus: "But no lot for me but Smith's Isles which are a many of barren rocks, the most overgrowne with

M. B. L. Calendar

TUESDAY, AUGUST 18, 8:00 P.M.

Seminar. Dr. Helen B. Smith, "Genetic Studies on Selective Segregation of Chrosomes in Sciara."

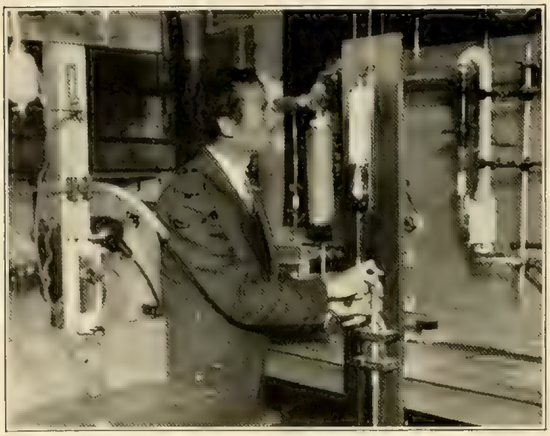
Dr. C. B. Bridges, "Specific Modifiers in Drosophila Melanogaster."

Dr. P. W. Whiting, "Local and Correlative Gene Effects in Mosaics of Habrobracon."

FRIDAY. AUGUST 21, 8:00 P.M.

Lecture. Dr. C. R. Stockard, Professor of Anatomy, Cornell Medical School, "An Experimental Dog Farm for the Study of Form and Type."

TABLE OF CONTENTS



THE BIOLOGICAL LABORATORY AT COLD SPRING HARBOR

DR. HUGO FRICKE, DIRECTOR OF THE BIOPHYSICS LABORATORY, IN HIS RESEARCH ROOM.

such shrubs and sharp whins you can hardly pass them, without either grass or wood, but three or four short shrubby old cedars."

The first impression of these islands is their barrenness,—rough, irregular rocks jutting up out of the sea. Low shrubs cover the islands with a sparse carpet, the bayberry, poison ivy, and blueberry being perhaps the most common, while in the crevices of the bare rocks, the tiny blossom of the scarlet pimernel adds a touch of color.

In his "American Note-books," Mr. Nathaniel Hawthorne describes these islands as he says: "It is quite impossible to give an idea of these rocky shores,—how confusedly they are bound together, lying in all directions: what solid ledges, what great fragments thrown out from the rest!—But it is vain to try to express this confusion. As much as anything else, it seems as if some of the massive materials of the world remained superfluous after the Creator had finished, and were carelessly thrown down here, where the millionth part of them emerge from the sea, and in the course of thousands of years have become partially bestrewn with a little soil.

It is impossible to describe the real beauty of the place. The barren wilderness surrounded on all sides by the gray sea gives it a charm that is peculiar to no other spot. Mrs. Celia Thaxter, the island poetess, has written: "There is a strange charm about them, an indescribable influence in their atmosphere, hardly to be explained but universally acknowledged."

Of the eight islands belonging to this group, White Island lies farthest out to sea and is the most barren of the group. Indeed, it is little more than a rock cliff, rising sheer twenty-five feet out of water on one side, with more gradual slopes on the others. On the east side a bay is formed, where floating seaweeds collect and fill the water with color as they are moved about by the tide. The rocks are smoother and less broken up than on the other islands, and the few pools which do occur are at the low tide level. Animal life is abundant around the island. The rocks are covered with colonies of Coelenterates of several species and the waters abound in the common species of fish. From the rocky cliffs on the south side, the bottom drops rapidly to a depth of nearly two hundred feet. Here are found haddock, hake, codfish, and occasionally one or another species of deep sea sculpin.

Londoner's is the next island and is somewhat larger than White Island. There are two high sections separated by a lower narrow strip of sandy beach formed largely of small pebbles and broken shells. This is one of the few islands where summer residents live. There is one small cottage on the north section of Londoner's, occupied for a few weeks during the summer.

Hundreds of terns nest yearly on Londoner's Island in the heavy brush which covers the island, or in depressions of the bare rocks which form a generous border of shore. This colony is composed largely of the common tern, *Sterno hirundo*, but there are also found a few pairs of the more uncommon roseate terns. Before the advent of the summer residents, this was a very large and interesting colony composed of several thousand individuals. The number is rapidly decreasing under continuous persecution and will undoubtedly be driven from the island within two or three years. Aside from the terns, this island holds little of interest for the biologist.

Star Island boasts the Oceanic Hotel where

THE BIOLOGICAL LABORATORY AT COLD SPRING HARBOR

THE CHEMISTRY LABORATORY IN THE NEW BIOPHYSICS BUILDING.

summer conferences of the Unitarian Association are held. The island itself is composed almost entirely of bare rock with very little soil or vegetation. There are a few small swampy areas of fresh water on the island to which a lusty colony of frogs claim first rights. The shore drops off rapidly into deep water except on the east side where a breakwater and the neighboring islands make a friendly harbor for fishing ships. Gosport Harbor is a splendid collecting ground. At the upper end of the harbor nearest the breakwater, depths of only a few feet occur, the bottom gradually sloping into depths of one hundred feet or more near the mouth of the harbor. This is a large sedimentation bay and numerous species of animals are found here which do not occur at any other point at the Isles of Shoals. Within the sheltered waters of the harbor, flounders, skate, wolf-fish, and many species of invertebrates can usually be secured for laboratory purposes.

Cedar is connected with Star Island by a breakwater. It is a small round island with no outstanding characteristic. Two families of lobster fishermen make their home but they apparently disturb very little the animal life which is of interest to the biologist.

Smuttynose, so named because the long ridge of rock which runs out into the ocean appears black to passing ships, is flatter and has a more regular surface than any of the other islands. About a third of the island is taken up by a rocky shore. In the center of the island is a fresh water swamp. The transition from the shore into deep water is more gradual here than on Star, White, or Londoner's Island and huge patches of Fucus break the force of the waves which pile up on its shores.

This island is a paradise to the biologist. Its interior is inaccessible to the average tourist and it presents more nearly unspoiled conditions than any of the other islands. Birds of numerous species nest here in abundance, particularly the song sparrow and the spotted sandpiper, and during the migration season, many unexpected visitors are found. In the rocky crevices along the shore, Leucoslenia, the finger sponge, and Coelenterates occur in abundance. Great colonies of hydroids, Metridium, and associations of starfish, and sea urchins may be found in the tidepools. Just offshore is a variety of sea bottom ranging from Cedar Island Ledge, which is exposed at low tide, to depths of nearly fifty fathoms. The bottom is of various types: sand, mud, bare rocks, and dense beds of Fucus. Off the shore of Smuttynose may be found colonies of sea cucumbers, blood stars, Ascidians, and many species of interesting deep-sea molluscs. A great variety of Crustaceans also occur both in the deep water and along the shore. These include, in addition to lobsters and the common rock crab, the interesting spider crab, deep water hermit crabs, and a great host of pelagic forms.

Duck Island lies about a mile northeast from the rest of the group. It is composed of broken rocks between which are narrow channels or passages. The largest of these rocks is only a few hundred yards in extent. The entire group is drenched from time to time during periods of heavy storm. This group of rocks is the home of thousands of herring gulls. Their nests and young cover the rocks so that one must walk with care in order not to crush them. When an intruder lands on the island, during the breeding season the air is filled with thousands of adults. Their screams can be heard almost continuously day and night at the laboratory, a mile distant. There is little in the way of vegetation on Duck Island. During the migrating season, thousands of ducks of various species collect in the vicinity of these broken rocks, where they find an abundance of food in the sheltered bays and channels. Duck Island is a wonderful collecting ground for invertebrates, especially those inhabiting comparatively shallow waters. An abundance of fish common to the shallow waters of the Shoals is found here. Cunners occur in enormous numbers and pollack, herring, and mackerel are frequently found in the surface waters around Duck Island.

Appledore Island is the largest of the Isles of Shoals group. It is about a mile long and a half mile wide. It is very roughly triangular in shape, with the apex towards the mainland. The narrowest part and also the lowest, is near the northern end, and during bad winter storms, is sometimes completely submerged, dividing the island into two portions. Appledore is higher than most of the other islands, the highest elevation being about sixty-seven feet above mean tide-level. The shoreline on Appledore Island is very irregular. On the west side the rocks are less broken and they slope off gradually into deep water towards Portsmouth Harbor. On the north and east shores the rocks are very irregularly scattered and high cliffs drop off precipitously into deep water of narrow ravines or into the open sea.

Along the shore, numerous tidepools of great beauty and interest are found. They range in size from tiny crevices that hold the water from one tide until the next, to large pools where abundant plant and animal life remain permanently, probably finding better protection than in the surf, yet gaining the benefits of the shallow water. These pools are filled with an abundance of Coelenterates, Molluscs, and other littoral forms.

Vegetation is relatively abundant on Appledore Island and many species of shrubs find it an excellent environment. A fresh water pond on the

higher portion of the island and a fresh water swamp at the opposite end give variety to the life that exists here. All of the different forms of invertebrates already mentioned are found in the vicinity of Appledore. Within five minutes walk the student from the laboratory may find a sufficient amount of material to employ his time for the remainder of the day.

The Marine Laboratory at the Isles of Shoals is an outgrowth of the regular summer school work at the University of New Hampshire. The Laboratory was established four years ago by a group of advanced students in zoology who felt that advantage should be taken of our proximity to salt water. We were particularly fortunate in securing a set of well built, although somewhat neglected, buildings formerly connected with the Appledore Hotel. These buildings have been thoroughly renovated and painted, and have been equipped with electric lights, running water, and modern improvements. Since the equipment of the zoology department on the university campus is only a few minutes from tide water, it is possible to secure any emergency supplies directly by boat from the University.

Owing to the generous support of the University authorities, and together with the cooperation of the Star Island Corporation, who had control of Appledore Island, practically the entire island was leased and is now constituted into a large field laboratory. Unhampered by any outside diversions, students are able to carry on eight weeks of study under ideal conditions.

The Laboratory is devoted primarily to the work of the undergraduate and first year graduate student. In this field there is little competition since most of the great marine laboratories are centers of advanced research work. The number at the Laboratory is limited to about thirty, although it is hoped in the near future to increase the facilities to accommodate a larger number of students.

The work is divided roughly into two fields. One is for the premedical student and includes comparative anatomy, histology, and embryology. It might seem that a marine laboratory is ill adapted to pre-medical work. However, the students find here an abundance of fresh material for the study of comparative embryology, comparative histology, and comparative anatomy. Furthermore, work in a research laboratory in contrast to a vocational environment, is of great value to the pre-medical student.

The second field covered is that of ecology and oceanography. Although this is of a very elementary nature, seniors and first year graduates are enabled to carry through many independent lines of investigation.

Some of the problems which are now in progress are as follows:

1. Ecological associations of deep sea areas in the vicinity of the Isles of Shoals. Apparently very little work has been done on deep sea ecology. The general oceanography of the Gulf of Maine has been thoroughly investigated. Animal communities, however, in water of more than two fathoms in depth are difficult to investigate. It is hoped that some interesting information may be secured along this line.

2. Ecological Studies of high tide pools. A paper on the physical, chemical, and biotic associations of high tide pools is nearing completion. Some interesting differences in the biota of certain of these pools have been found.

3. Ecological studies of marine sponges. A systematic and ecological study of the marine sponges of the Isles of Shoals has been carried on for the past four years. It is hoped that this will be extended to include all of the sponges of the Gulf of Maine.

4. Ecological studies of the fish of the Isles of Shoals. The Shoals were at one time noted as the center of the fishing industry for the southern portion of the Gulf of Maine. A considerable change has taken place in the relative abundance of certain species of fish: some having disappeared entirely, while others have apparently become more abundant. The entire problem of the fish population of the Isles of Shoals is being investigated.

5. Ecological survey of the birds of the Isles of Shoals. The Isles of Shoals are most favorably situated for the study of the bird population. This is especially true of those forms which follow the coast line in their migratory flight. By glancing at the map, it will be seen that these islands lie within the Gulf of Maine, having land to the northeast and to the southeast. Birds flying in a direct line from Cape Elizabeth to Cape Ann pass within a comparatively short distance from the Isles of Shoals and great numbers make this a resting place. Owing to the sparse vegetation, bird study is rendered comparatively easy and a census of the relative abundance at any given time may be readily taken. Preliminary papers on bird migration and the general ecology of the resident birds are now practically ready for the press.

6. Embryological studies of the herring gull have been carried on for the past two years. The abundance of material on Duck Island has made this a profitable line of work.

7. A study of the fresh water Protozoa of Appledore Island has been carried on, revealing, however, little unexpected material.

8. An attempt is being made to determine the possible effect on the embryological development of the albino rat when carbon monoxide is ad-

ministered to the mother during the period of gestation. This is a problem connected with the pre-medical work and will be continued on the campus. Preliminary experiments seem to show that death or weakening of the offspring occurs when the mother has been submitted to sufficient quantities of this gas.

9. Studies on parasitic protozoa are in progress. Dr. Swan of Trinity College is rendering valuable assistance in this work.

Minor problems in the taxonomy of various groups, histology, and experimental embryology are being carried out by undergraduate students.

An experiment which has been in progress during the past three years is an attempt to establish a tern colony on north head of Appledore Island. Young birds have been brought over from Londoner's and raised to maturity. We are still uncertain whether or not the colony will be permanent.

A complete biological and ecological survey of the Isles of Shoals is contemplated in the near future. Much of the material from the above problems will ultimately be incorporated in this survey. With this in view a set of problems of strictly oceanographic nature have been outlined including the determination of depths and bottom within a three mile radius, water analysis, currents, temperatures, and the relation of these factors to the distribution and migration of fish and certain of the invertebrates. Plancton studies will also accompany this work.

Nothing of originality is claimed for the work of this laboratory. It is hoped that it will be primarily a stimulus to the young investigator who may go on in productive research. The time may come when our facilities can be increased to accommodate the seasoned biologist. Until that time, it is felt that the Laboratory is performing a real service in an attempt to stimulate interest in research work both in those planning to enter the medical profession and in those students interested in the purely scientific phase of zoology.

IS THE PERMEABILITY OF THE ERYTHROCYTE TO WATER DECREASED BY NARCOTICS?

(Continued from Page 197)

In the absence of this necessary information, hemolysis experiments are entirely useless for the purpose of measuring cell permeability.

In the work here reported, advantage was taken of a method previously described by one of the authors (*Biological Bulletin*, 1930) which permits the entire course of the hemolytic process in such experiments to be followed and recorded over a period of several hours. Inspection of the records so obtained in the presence and absence of several narcotics shows immediately that what was observed by Arrhenius and Bubanovic and other workers as a result of the presence of such substances was not a change in the rate of hemolysis, and, therefore, by implication, a change in the rate of penetration of water, but rather a mere change in the degree of hemolysis ultimately attained; that is, in the osmotic resistance of the cells. Experiments of the type previously reported, therefore, give no clear evidence either for or against the "permeability" theory of narcosis.

That a decreased permeability of the cell may be produced by narcosis is, however, suggested by results obtained with very strongly hypotonic solutions in which true rates of hemolysis may be measured with considerable accuracy by a modification of the method already described. In such experiments the presence of phenyl or iso-amyl urethane in concentrations lying within the physiological narcotic range produce a slowing of hemolysis which, though comparatively slight, is nevertheless easily measurable. It is entirely possible, therefore, that such narcotics may slow the rate of entrance of water into, or the escape of hemoglobin from the erythrocyte, or both, in the manner demanded by the permeability theory of narcosis. It should be emphasized, however, that such results by no means prove that a condition of narcosis is generally, or even sometimes, produced by a decreased cellular permeability; it is possible merely to state that the facts here reported are not incompatible with such a theory.

A provisional, though purely hypothetical explanation of the effect of narcotics, both on the rate of hemolysis and on the position of final equilibrium of the system, may be given in terms of the so-called "pore" theory of permeability, if it be assumed that molecules of the narcotics are adsorbed by the erythrocyte in such a way as to diminish the effective diameter of the "pores". The effect of such a change, in the pathways by which water might be assumed to enter the cells, on the rate of hemolysis is obvious. An explanation of its effect on the degree of hemolysis ultimately attained could similarly be furnished by imagining a sufficient degree of blocking of the enlarged "pores" in a swollen erythrocyte, to maintain their normal impermeability to hemoglobin molecules. In the absence of conclusive evidence of the presence of such "pores" in the surface of the erythrocyte, such an explanation is, of course, to be treated merely as a convenient, though rather crude, working hypothesis, which might readily be abandoned without in any way changing the significance of the observed facts.

THE FIBRILLAR SYSTEM OF EUPLOTES

John P. Turner
Instructor of Zoology, University of Minnesota

The neuromotor apparatus of the ciliate *Euplotes* is probably better known than that of any other protozoan—which, after all, is not saying a great deal.

Following the original description by Sharp in 1914 of the neuromotor apparatus of the ciliate *Diplodinium,* an inhabitant of the stomach of the cow, Yocum in 1918 described the neuromotor system of *Euplotes patella,* which is similar to that of *Diplodinium* in that it consists chiefly of fibers extending from a coordinating center, the motorium, to the motor organelles.

Taylor, in 1920, demonstrated the co-ordinating nature of this system by cutting various fibers and observing the subsequent lack of coordination between the cirri and membranelles to which the fibers had extended. Rees, MacDougall and others have followed with descriptions of neuromotor systems of various degrees of complexity, some with and some without a definite motorium.

Klein has recently called our attention to the delicate system of fibrils near the surface of ciliates which he calls the "silver line system" from his method of demonstrating it with silver impregnation. He pictures the lines following the basal bodies in the rows of cilia. These ciliary rows have been known, of course, for many years, and partly described.

One of the forms which Klein studied was *Euplotes harpa.*

In applying his method to *Euplotes patella* I have been unable to obtain satisfactory preparations. However, by modifying his technique sufficiently I have obtained some striking preparations.

Bear in mind that *Euplotes* has no cilia on the dorsal surface. Nevertheless, the lines are present. Furthermore, they connect up rows of granules, arranged in rosettes, which some believe to be basal bodies of ancestral cilia. If this assumption is correct, they have changed their size, arrangement, function and affinity for stains. Data regarding these points will be discussed in a future publication.

There are nine longitudinal rows of these rosettes, each row containing about twenty-five rosettes. The rosettes in turn are each composed of from six to twelve large granules.

Griffin, in 1910, described sensory bristles protruding from the rosettes in *Euplotes worcesteri.* Klein, with his silver method, shows only single blots for the rosettes in *Euplotes harpa.*

As can be clearly seen even in photomicrographs, the dorsal surface of *Euplotes patella* shows nine longitudinal fibrils which connect up the rosettes. These I have called the primary fibrils. There are also less regular but quite distinct secondary fibrils which are between and parallel to the primaries. In addition, there are commissural fibrils extending across from the primaries to the secondaries, creating a veritable network or latticework which varies from one organism to another remarkably little.

In every case, the rosettes are located between the intersections of the commissural with the primary fibrils, which indicates that they are not merely nodes of attachment. The entire network is connected anteriorly with the membranelle fiber of the neuromotor system.

The network of the ventral surface of *Euplotes patella* is much more complicated than that of the dorsal side. Instead of the fibrils forming squares and rectangles in parallel rows, they are arranged in an irregular fashion, forming long, slender rectangles, pentagons, hexagons, etc., according to their location. This gives somewhat the appearance of badly treated chicken wire. The pattern, however, is constant and characteristic. The basal plates of the adoral membranelles, the slender rectangles formed by the fibrils posterior to the peristome, and the more regular pattern in the region of the oral lip are particularly noticeable.

Now questions naturally arise as to the *meaning* of all this fibrillar network. Is it an artifact? If not, what is its function? Is it a part of the neuromotor apparatus?

I believe it is not merely an artifact, for three reasons:

(1) Because of its constant and regular appearance when impregnated with silver in either unfixed, dried material, according to Klein's method, or in material fixed with osmic vapor.

(2) The entire system appears clearly in material stained only with thionin.

(3) I have seen the primary fibrils in living material stained with neutral red. They appear as delicate threads extending through the rows of rosettes. The rosettes show beautifully in neutral red stained material.

If we accept these facts as evidence of the reality of the network, what can we say of its function?

Klein believes it is a primitive nervous system with both motor and sensory functions, and he interprets Taylor's results as the effect of cutting the network. He also states that it, in some way, initiates division of the cell (I believe I can show

this is not true.) He assigns various other functions to the network, but, in all cases, what little evidence he presents is not convincing.

There is, however, a suggestion as to its possible function. Yocum and Taylor describe one row of fibrillar hexagons in the oral lip of *Euplotes patella* which arises from the neuromotor apparatus. This they believe to have a sensory function and Taylor demonstrated that the oral lip is the most sensitive part of the animal. Now these hexagons are only a small, though easily demonstrable, part of the fibrillar network. We see then that the network is intimately connected with the neuromotor system and that at least a part of it seems to have a sensory function.

As I have already pointed out, Griffin states that sensory bristles protrude from the rosettes in *Euplotes worcesteri*.

So it may be that the fibrillar network in *Euplotes* is sensory in function and supplements the neuromotor system as a sensory apparatus. It is just under the pellicle where one would expect to find such a system.

This possibility needs testing, of course, and I hope to find methods which will yield further evidence.

TYPES OF VARIATION PRODUCED BY CONJUGATION IN PARAMECIUM AURELIA

Dr. Daniel Raffel
National Research Council Fellow in Biology, Johns Hopkins University

The object of this paper is to give a general account of the types of variation which were produced by conjugation in a clone of *Paramecium aurelia* in an investigation which Professor Jennings, Drs. Lynch and Sonneborn, Mrs. Raffel and I began here last summer.

The members of a clone of Paramecium, i. e. the individuals descended from a single organism in the absence of conjugation are remarkably uniform in their characteristics. However, Jennings found in 1913 that after conjugation occurred in such a clone this uniformity is destroyed. He found that the variability of the fission rates in such a population is much greater than in a population composed of individuals of the original clone which had not been allowed to conjugate. I recently undertook a reinvestigation of this problem, using such methods of cultivation as to eliminate the possibility of environmental factors influencing the results obtained, and my results entirely confirmed those of Jennings. Therefore it seemed of great interest to ascertain what types of variation are produced by conjugation, i. e., what kinds of characteristics are inherited by Paramecium.

A single individual of *P. aurelia* was isolated from a mass culture in the laboratory and its progeny were allowed to multiply until a great number had been obtained. Then conjugation was induced in this clone and 258 pairs were obtained. After the members of the pairs had separated, they were isolated and from each of the 516 organisms a single line of descent was kept. These 516 lines were cultivated for ten days and records were kept of their fission rates and any obvious peculiarities of any of the lines which were observed. At the end of the ten days, all but 49 of the lines were discarded. Further intensive study was devoted to the 49 lines which were retained. I made an intensive study of 11 of these clones and it is with the results which these clones yielded that this paper will treat. In general 24 lines of each clone were carried for the next 40 days. The results are based almost entirely on the data which I collected on these clones. These data are typical of the results which all of us obtained.

The clones differed in many respects: namely in their (1) general vitality, (2) fission rates, (3) reactions to endomixis, (4) sizes and shapes, (5) uniformity (6) the production of abnormalities, (7) the effect of conjugation on them, and (8) reactions to different changes in their environments.

In the first place, striking diversities were shown in the general vitalities of the different clones. After conjugation there were 516 exconjugants. Of these, 96, or nearly 20%, died in a short time without dividing. In addition to these, 179 lines of ex-conjugants died out within 9 days of the time they conjugated. Some of these latter lines were, from the beginning, weak and sickly — they divided slowly and produced weak and often abnormal offspring; others of these clones appeared vigorous for a few days and divided frequently, only to die in a short time. Other clones lived for longer periods, declined in vigor and died. Still others of apparently low vitality lived for long periods but divided very slowly during the ten months that they were studied. Finally, other clones were extremely healthy and vigorous and the one such clone which was kept lived for more than 300 days without showing any decrease in vigor.

Some idea as to the diversities in vitality of the group which lived for longer periods of time is given by the diversities in the rates of reproduction among the different clones. The eleven

clones varied in their daily fission rates from 1.08 fissions per day to 2.19 fissions per day for a period of 60 days during the greater part of which time 24 lines of each were carried. There was a rather complete series of fission rates between these two extremes. The differences in fission rates persisted and the clones with the higher fision rates reproduced more rapidly during the successive periods than the clones with the lower mean fission rates. Thus we see that conjugation certainly produces clones which differ in their rates of reproduction.

Another interesting difference between the clones was found in their reactions to endomixis. Some of the clones showed no indication of any depression during endomixis. Their fission rates fell off but slightly for a day or two and then rapidly recovered. These produced few if any abnormalities and on the whole were relatively unaffected by endomixis. Other clones were seriously depressed for several days and produced many abnormalties while they were undergoing this process. In some of these, endomixis was such a serious process that it was at times doubtful whether they would survive. In one clone which had manifested the highest degree of vitality of any, endomixis proved fatal.

The clones varied greatly in their tendencies to produce abnormal individuals; some produced many such individuals, others produced some periodically, while still other clones produced very few abnormal individuals or none at all.

There were also differences in size and form apparent among the different clones. Most of these differences were small and they were not studied intensively. However, one clone differed greatly from all of the others. This was only about one half as long as the others and had a spindle-like shape. A comparison of this clone with any of the others shows great diversity in size and form which conjugation can produce.

A very unexpected and interesting difference which was found between the clones was the diversity in their uniformity. Jennings found in 1908 that they were very uniform in their characteristics. In these clones this was generally true. A clone called 128a, however, occasionally produced lines which differed from the other lines of the same clone in their size, shape and rate of reproduction. These aberrant lines were in every case similar and never were known to revert. This type of variation is quite different from that produced by conjugation. Conjugation produces a number of clones which differ from each other in varying degrees while in this case all the descendants of the clone 128a are of one of the two kinds. One other clone which I studied also produced aberrant branches from time to time. However, in most of our work we obtained the same kinds of results that Jennings had earlier—clones are uniform and selection is ineffective.

Clones vary in the effects that conjugation have on them. Dr. Ruth S. Lynch is giving a full report of this type of variation so I shall say nothing about it here.

Jennings in 1913 came to the conclusion that conjugation within a clone produces a varied population containing many diverse clones some of which will thrive under one set of conditions and others under different sets of conditions. In order to test this hypothesis I made a study of the reactions of a few clones to different environmental conditions. The first comparison which was made was with respect to a general difference. I cultivated my organisms in a salt solution to which cultures of known bacteria and algae were added. The details of this medium have been published.* The others working in this investigation used an oat infusion to which the same algae were added. Unfortunately we devoted our attentions to different clones so that, when we came to make the comparison, there were only two clones on which we both had sufficient data to compare. These two, however, showed a marked difference in their reaction to the two media. In the oat infusion they made records which were practically identical. In the salt solution, on the other hand, one clone reproduced much more rapidly than in the oat infusion and the other reproduced much more slowly. Obviously then, conjugation produces clones which react diversely to different media.

I performed a series of experiments to determine the reactions of the different clones to small, known differences in the environment. The first of these experiments was designed to test whether the different clones would react diversely to a decrease in the quantity of bacteria which was supplied in the medium. In carrying out this investigation two sets of media were prepared daily. Each set was made in a tube containing about 15cc. of the sterile culture solution. To these were added approximately the same quantity of *Stichococcus bacillaris.* To the tube of control medium a pipette (approx. 1 cc.) of a rich suspension of *Achromobacter candicans* was added while to the tube containing the experimental medium only a single drop was added. Sister individuals of the 24 lines of each clone to be tested were transferred into this medium. Then both sets were cultivated for 15 days using the necessary precautions to exclude bacteria. In calculating the results, this 15 day period was divided into two of 7 and 8 days each. The clones differed greatly in the extent to which their rates of reproduction were depressed by this decrease in the quantity

*Raffel, D.. The effects of conjugation within a clone of Paramecium aurelia. Biol Bull. 58: 293-312, 1930.

of bacteria in the medium. The extent of the depression in the two periods was very similar in the case of most of the clones. There was, however, some variation in the extent of the depression in the two periods in some of them. This was due probably to the occurrence of endomixis and was not sufficient to obscure the variation which was apparent in the reactions of most of the clones to this change in environment. The evidence is clear that some of the clones do differ in their reactions to a decrease in the quantity of bacteria supplied to them.

Another environmental agent tested was a decrease in temperature. The control group was cultivated at a temperature varying from 25° to 27° while sister animals were cultivated in the identical medium at 18.5 to 20.0°. Three experiments were performed to test the reactions of 5 clones to this decrease in temperature. The results which were obtained were similar to those obtained from a decrease in the quantity of bacteria. The five clones which were tested varied greatly with respect to the degree to which this decrease in temperature depressed their fission rates. The three experiments showed the same differences between the clones. The one which was most depressed during the first experiment was most depressed during the second and third. In the same way the one which was least depressed during the first experiment was depressed least in the others. The other three were also depressed in proportional amounts during the three experiments except that two were interchanged during one period. Thus conjugation produces clones which vary in the extent to which this decrease in temperature will depress them.

The third environmental difference which was studied was a decrease in the pH of the medium. In the three experiments which were then performed on this difference, 24 lines of each clone were cultivated in the usual medium which had a pH of 7.2, and in a medium which was the same in every respect except that it had a pH of 6.8. The results of these three experiments showed that the clones differed greatly in their reactions to this decrease in pH. One of the clones was not depressed in any of the three experiments, one was very slightly depressed in all three, others were more depressed in varying degrees. A few of the clones showed different reactions in the three different experiments, probably due to the effects of endomixis which occurred during the progress of these experiments. These experiments demonstrated that the clones produced by conjugation differ in their reactions to a decrease in pH.

The study of these eleven clones demonstrates beyond a doubt that conjugation produces variation in vitality, rate of reproduction, reaction to endomixis, size and form, uniformity, production of abnormalities and reactions to various differences in the environment. These differences are independent of one another and are not all phases of differences in vitality. Clones which were of high vitality and reproduced rapidly were often depressed more by endomixis or various environmental agents than were others of lower vitality.

It is obvious that conjugation within a clone of *Paramecium aurelia* produces many clones which differ in numerous respects. Each of these eleven clones is different from each of the others in one or more ways It seems probable that, by using a sufficiently large number of criteria, each exconjugant could be shown to give rise to a unique biotype.

EFFECTS OF CONJUGATION IN A NUMBER OF CLONES OF PARAMECIUM AURELIA

Dr. T. M. Sonneborn,
Research Associate in Genetics, Johns Hopkins University
and Dr. Ruth Stocking Lynch,
Instructor in Genetics, Johns Hopkins University

(Reported by Dr. Lynch)

Dr. Raffel has described the types of variation brought about in *Paramecium aurelia* as a result of conjugation. I shall attempt to show how some of these types of variation (diverse fission rates, variabilities, and mortality percentages) are manifested in closely related clones of the same species.

Conjugation effects have generally been considered identical for all species of ciliate Protozoa, although it has been suggested that the various species might differ in this regard. But the idea that conjugation might affect various stocks of the same species differently has been little considered. However, certain results obtained by Calkins on Uroleptus; by Woodruff and Spencer on Spathidium; by McDougall on Chilodon; and by our own group in work still unpublished, strongly support the idea that such a diversity in effects of conjugation may occur even within a single species. Such diversity, particularly if it is found to be wide-spread, might account for the conflicting results obtained by various investigators and the consequent diversity of their theories of conjugation.

For this reason, among others, the variability of conjugation effects in closely related clones was studied by Dr. Sonneborn and myself during the past winter. The problem was attacked in three ways. A study was made, (1) of repeated conjugations within one clone; (2) of simultaneous conjugations in six closely related clones; (3) of repeated simultaneous conjugations in two closely related clones.

Clone 247a, one of the forty-eight clones used in the investigation described by Dr. Raffel, was the parent of all the clones studied. It was kept under examination during the entire course of the investigation. Three successive conjugations were induced in a portion of this clone on October 1 and 16, and on December 9, 1930. In each case, after fourteen or more days of examination, all the resulting daughter clones were discarded, with the exception of six from the last conjugation which were kept for use in the second set of experiments.

This second set of experiments consisted of the induction and study of simultaneous conjugations in these six sister clones. All of the resulting 288 daughter clones were discarded at the end of the experiment, and all but two of the parent clones. Two of the parent clones, E40a and E81a, were kept and studied throughout the rest of the investigation.

The third and last set of experiments consisted of a series of three more simultaneous conjugations, induced in these two sister clones.

The rest of this report is a consideration of the results of these fifteen conjugations.

In the first conjugation induced in a part of cone 247a, 116 lines, one from each member of the 58 pairs isolated, were studied. Their mean total number of fissions was 15.70‡0.16*; the mean total number of fissions in the co-existing non-conjugant lines was 15.78‡0.29, almost exactly the same; their ratio is 1.00. In the second experiment, the mean total number of fissions for 100 conjugant lines was 13.87‡0.27; that for the co-existing non-conjugant lines was 13.74‡0.21; their ratio is 1.01. In the third experiment the mean total number of fissions for the 194 conjugant lines was 19.26‡0.23; for the non-conjugant lines, 18.32‡0.17 their ratio is 1.05. It is quite clear that the mean fission rate of the clone 247a is unaffected by conjugation.

The second method, the study of simultaneous conjugations in a number of sister clones, was applied to the descendants of six conjugants from the last experiment. Conjugation was induced in all six on January 12 to 14, and the descendants of 48 pairs of each group of conjugants, together with non-conjugants of each parent clone, were studied for fourteen days.

* This symbol "‡" indicates "plus or minus."

In mean total number of fissions the six groups of conjugants fall into two classes; Class 1 contains five of the groups: Class 2 contain only the E81a group. The five members of Class 1 show but slight differences. For the members (E41a and E80b) showing the highest and lowest mean total number of fissions in Class 1 the means for the first five-day period were 16.69‡0.19 and 16.38‡0.19. In the E81a group (Class 2) the mean total number of fissions was 7.46‡0.42; less than half that of every member of Class 1. For the two representatives of Class 1 in the second five-day period, the mean total number of fissions was 13.66‡0.18; and 13.26‡0.24. In the E81a group the total number was 5.39‡0.59; again less than half those of Class 1. For the total time, the mean for the highest member of Class 1 was 30.46‡0.34; for the lowest member, 29.76‡0.40. For the one member of Class 2, it was 15.06‡1.04; again half as high. These two classes of conjugants from sister clones show a difference of 100% in their mean fissions rates.

This difference between the groups of conjugants is paralleled by the difference between their relations to their groups of non-conjugants. These relations are expressed by the ratios of conjugant total number of fissions over non-conjugant total number of fissions. The ratios for the group E41a are 1.00, 1.01, 1.01; its mean fission rate has been unchanged by conjugation. It is similar in this respect to clone 247a, the first clone studied. The corresponding ratios for the group E80b are 1.12, 1.02, and 1.07; its fission rate has been slightly but consistently *raised* by conjugation. The ratios for E81a, on the other hand, are 0.54, 0.61, and 0.70. Its mean fission rate has been consistently and markedly *lowered* by conjugation.

This simultaneous comparison of the effects of conjugation in six sister clones demonstrate that conjugation does not have the same effect on mean fission rate in all clones; in some clones, conjugation raises the mean fission rate (rejuvenescence); in other clones, conjugation lowers the mean fission rate (depression); in still others it leaves the mean fission rate absolutely unaltered. Some groups of conjugants may have a fission rate twice as high as the rate in other groups. It is apparent that each of the different results obtained by different investigators can be attained by studying the appropriate race; the effects of conjugation on mean fission rate depend on the nature of the race which conjugates.

In variability these six groups again fall into three distinct classes: (Class 1) those whose variability is low; (Class 3) those whose variability is high; (Class 2) those with an intermediate variability.

In Class 3 are the conjugants of E81a; their standard deviations of 3.98±0.30 for the first period, 3.86±0.41 for the second, and 6.56±0.74 for the total time, show a variability distinctly higher than that of any other group. In Class 1 are the conjugants of E40a, with standard deviations most unlike those of E81a; they were the lowest found (1.44±0.07, 1.60±0.08, and 2.68±0.14.) The intermediate class is represented by E41a, its most consistent member; its values are 2.66±0.14, 2.52±0.14, and 4.63±0.24. These conjugant groups, derived from sister clones, show variabilities of widely different degrees.

Difference in *increase* in variation is shown most clearly by the clones E41a and E40a. In these two clones the ratios between the standard deviations of the conjugant groups and the corresponding non-conjugant groups show that conjugation increased absolute variability about twice as much in the clone E41a as in the clone E40a. (The ratios for the two five-day periods and total time are: 2.74 as compared with 1.32; 1.91 as compared with 1.04; and 2.82 as compared with 1.23).

These results are another instance of disagreement of data obtained from different clones. An experiment on E40a alone would have led to the conclusion that conjugation does not increase variability; but an experiment on E41a alone would have led to the conclusion that conjugation greatly increases variability. The present experiment shows that neither conclusion tells the whole truth.

In percentage mortality the six groups of conjugants again fall into three classes. In Class 3 are the conjugants of clone E81, with a very high mortality: 81.3%. In Class 1 are those from E40a and E41a, with a very low mortality: 11.5% and 12.5%. The other groups fall into the intermediate class, with a mortality percentage ranging from 24.2% to 37.5%. It is evident that mortality, also, varies with the clone; in some clones conjugation results in a very great mortality; in other clones, in very little.

The differences between the mortality percentages of the conjugants and the mortality percentages of the non-conjugants bring out the same type of relations. Conjugation lowered mortality in E80b (0.8%); left it absolutely unaltered in E85b; slightly raised it in E46b (10.7%), E41a (11.5%), and E40a (12.5%); and raised it greatly in E81a (43.8%). Non-conjugant members of both E85b and E81a had a mortality of 37.5%; conjugation increased this to 81.3% in daughter clones of E81a, but left it unchanged at exactly 37.5% in the daughter clones of E85b. In some clones conjugation increases the mortality; in others, it leaves it unaffected.

The third method was carried out on the two parent clones of the second experiment which had shown the greatest diversity in all effects of conjugation studied: E40a and E81a. This study of repeated simultaneous conjugations in these two sister clones was designed to answer the question: What difference between E40a and E81a in the effects of conjugation will be found repeatedly and at different times?

The first conjugations studied simultaneously occurred of course in the second set of experiments just described. The second were induced February 9 to 12; 48 pairs from the E40a clone and 44 pairs from the E81a clone and their descendants were studied. The third occurred Feb. 15 to 18, and 48 pairs of E40a and 96 pairs of E81a and their descendants were studied. On March 11 to 16 the fourth and last simultaneous conjugations were induced and 20 pairs of E40a conjugants and 21 pairs of E81a conjugants and their descendants were studied.

In every period the mean total number of fissions of the conjugants of E40a is significantly higher than the mean total number of fissions of the conjugants of E81a: 16.26±0.10 as compared with 7.46±0.42; 13.70±0.12 as compared with 5.39±0.59; 5.51±0.16 as compared with 2.83±0.27; and 10.41±0.32 as compared with 6.00±0.30. There can be no doubt that conjugation in the clone E40a yields groups of conjugants with higher mean fission rates than does conjugation in the clone E81a.

The coefficients of variation also show consistently significant differences. The coefficients of the E40a groups of conjugants are always less than the coefficients of the E81a groups: 8.87±0.46 as compared with 53.38±4.98; 11.69±0.62 as compared with 68.36±10.69; 38.43±2.28 as compared with 77.38±9.99; 30.52±2.34 as compared with 52.08±4.31. Obviously, conjugants from the clone E81a are relatively much more variable in fission rate than conjugants from the clone E40a.

A comparison of these conjugant values with the corresponding non-conjugant values brings out characteristic effects in each clone. The mean total number of fissions for E40a in the first period of the first experiment is 14.25±0.26; for its conjugants, 16.26±0.10—the fission rate has been slightly raised by conjugation; the ratio between the two totals is 1.14. This is also true of the second period in which the ratio is 1.04. In the third experiment it has been slightly lowered: the ratio is 0.90; in the second experiment, lowered still more: the ratio is 0.60. In E81a, on the other hand, the total number of fissions for the conjugant group is always considerably less than that for the non-conjugants: the ratios in every case are close to one half; and, in every period, they are almost exactly half the ratios for E40a. They are 0.54, 0.61, 0.33, and 0.48. It is clear that in E40a the fission rate is usually

little affected. In E81a, it is regularly about halved.

The same thing is true for variability. The ratios for E81a are in every case greater; in three cases, over twice as great: 4.18 as compared with 1.16; 1.69 as compared with 1.00; 10.87 as compared with 5.38; and 4.16 as compared with 2.01. Variability in E81a has been regularly increased by conjugation to a much greater extent than in E40a.

The two clones show similar differences in effect of conjugation on mortality. In every experiment the mortality of the E40a group of conjugants is very much less than the mortality of the E81a group of conjugants: 12.5% as compared with 81.3%; 14.3% as compared with 40.9%; 71.9% as compared with 99.5%; 47.5% as compared with 92.9%. For the four experiments the average mortality among the conjugants of the group E81a was 81.3% as compared with 36.1% for the conjugants of the clone E40a. There can be no doubt that conjugation results in a very much greater mortality in the clone E81a than in the clone E40a.

A comparison of the differences between mortality percentages of the non-conjugant and conjugant groups brings out specific effects in each clone. In E40a, the conjugant percentage is greater in the first experiment by 12.5% in the second, by 14.3%; in the fourth, by 7.5%. In the third experiment, the mortality of the conjugants is *less* by 3.1%. It is evident that mortality in E40a is little affected by conjugation. In E81a, however, the mortality percentage is regularly considerably higher in the conjugants: 43.8% in the first experiment; 40.9% in the second, 18.0% in the third, 22.1% in the fourth. In E81a conjugation regularly and significantly increases mortality.

Thus repeated comparison of successive groups of conjugants from the two clones E40a and E81a as well as the study of successive groups of conjugants from 247a has fully established that each clone shows certain characteristic effects of conjugation. Conjugants from clones 247a and E40a have a high fission rate similar to that of their parent clones; conjugants from E81a, a low fission rate, about half that of their parent clone. Conjugants from E40a have a low variability, slightly greater than that of their parent clone; conjugants from E81a a high variability, considerably greater than that of their parent clone. Conjugants from E40a have a low mortality, like that of their parent clone; conjugants from E81a a high mortality, well above that of their parent clone.

In conclusion it may be stated that in this investigation, fifteen conjugant groups from seven closely related clones were found to be very diverse in fission rate, variability, and mortality. Groups of conjugants obtained over a period of three months from two sister clones differed consistently in fission rate; the ratio of the slower over the faster never exceeded 0.58. Differences of similar degree were found in variability and mortality, extending over the same three months period.

The relations between conjugant groups and parent clones were also very diverse. Most clones showed no effects, or very slight effects, in their fission rates. In others, the fission rate was raised by conjugation; in one it was strikingly reduced. The same is true for mortality. Variability was usually increased, but to very diverse degrees in the several clones. We found no uniform conjugation effects in the species *Paramecium aurelia.*

However, within each of the three clones in which three or more successive conjugations were studied, certain characteristic effects of conjugation were demonstrated repeatedly. In one clone (E81a) fission rate was halved; mortality was greatly increased; and variability was doubled. In two clones, (247a and E40a) fission rate was unaffected; in one of these two (E40a,) mortality and variability were also little increased.

In general, then, according to these results, conjugation effects are specific for certain clones of *Paramecium aurelia,* but are highly diversified in the species.

CROSS-CONJUGATION IN PARAMECIUM AURELIA

DR. T. M. SONNEBORN AND DR. RUTH S. LYNCH,
Johns Hopkins University
(Reported by Dr. Sonneborn)

Although cross-breeding experiments are obviously important for genetic analysis, only three cases in which cross-breeding is definitely known to have occurred are to be found in the whole of protozoan literature. The best of these is the cross made by Pascher between two species of Chlamydomonas. This, however, will not be described, as the present account will be confined to the ciliate Protozoa, in which the phenomena of mating are very different from those in flagellates like Chlamydomonas. The first clear case of cross-breeding in ciliate protozoa is the single pair of cross-conjugants of *Spathidium spathula* obtained by Woodruff and Spencer in 1924. The descendants of this one pair were compared for 25 days with the descendants of two pairs of inbred conjugants from each parent clone. No significant differences in fission rate were found. The only other case is the work of Miss MacDougall on Chilodon. Fifty pairs of cross-conju-

gants between a normal and a tailed race were obtained, but every one of these died before they could be studied She states, however, that another type of cross has been more successful; but no account of this has yet been published. These two cases of Woodruff and Spencer and of Miss MacDougall exhaust the literature on cross-breeding ciliate Protozoa.

In an attempt to help fill in this gap in the genetics of these organisms, a method was developed by which clones of *P. aurelia,* with different genotypes, could be cross-bred. The chief difficulties in achieving this are due to the facts that conjugation is ordinarily induced in mass cultures and that, in mass cultures, the two clones to be crossed cannot usually be distinguished with certainty. These difficulties must be overcome either by artificially marking in different ways the two clones to be crossed, before mixing them in mass cultures; or by devising some method whereby conjugation can be induced in isolation cultures containing only two individuals—one from each clone. Both methods were tried and the latter found to be far more satisfactory.

The method finally used was essentially this: Conjugation was induced synchronously in separate mass cultures of the two clones to be crossed. Then, pairs consisting of one non-conjugating individual from each of the two clones were isolated together in the smallest possible amount of fluid taken from one of the conjugating cultures.

After this technique had been successfully employed, it was discovered that Woodruff and Spencer had obtained one pair of cross-conjugants (the one already mentioned) by the use of a somewhat similar method. The essential difference in method is that they set up pairs in ordinary culture fluid instead of in fluid from the conjugating cultures. This difference may account for their failure to get more than one pair of cross-conjugants.

That the method here employed will probably be found to be of wide-spread usefulness is indicated by the facts that we have obtained crosses among five genotypically different clones of *P. aurelia,* and Mr. Cohen, using the same method, has just succeeded in crossing different races of a very different species: *Euplotes patella.*

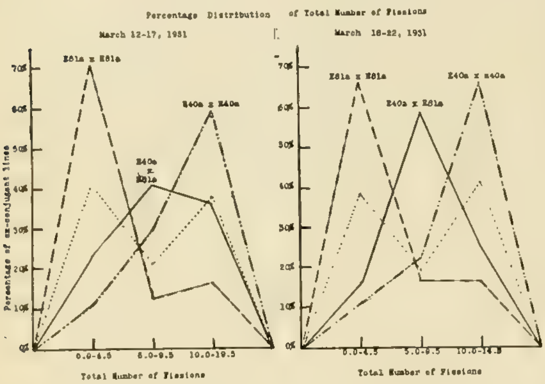
Of the different crosses we have obtained, one was done on a large enough scale to yield results of interest. The experiment was performed on two of the clones of which Dr. Lynch has just given you an account: The clone E40a, which, when inbred, yielded groups of ex-conjugant clones with high mean fission rate and high viability; and the clone E81a, which, when inbred, yielded groups of ex-conjugant clones with low mean fission rate and low viability.

During the fourth of the comparisons of the effects of inbreeding which we made between these two clones, we also studied twenty pairs of crosses between the two clones. The conjugants of the three groups were obtained at the same time. From each ex-conjugant we ran two lines of descent, so that we had eighty cross-bred lines to compare with eighty inbred lines from one parent and eighty inbred lines from the other parent. The experiment thus consisted of 240 lines. These were compared for twenty days. The present report will be limited to a discussion of two characteristics: Fission rate and viability.

In mean fission rate, the three groups differed greatly. The inbred E40a parent yielded a group of ex-conjugant lines with means of 10.61, 9.48, 10.77, and 12.52 fissions for the four successive five-day periods, respectively. The inbred E81a clone yielded a group of ex-conjugant lines with means of 3.77 and 4.58 fissions for the first two periods, respectively. (The means for the last two periods for this group are not given because the descendants of only three ex-conjugants survived these periods, and their means are obviously insignificant.) The cross-bred group yielded a group of ex-conjugants with means of 7.73, 7.57, 7.97, and 9.28 fissions for the four successive five-day periods, respectively. Period by period, the means of the cross-bred group are lower than the means of the inbred E40a clone (by a total of 10.8 fissions for the 20 days of the experiment), and higher than the means of the inbred E81a clone (by a total of over 7 fissions for the first 10 days of the experiment.)

It is important to inquire into the possibility that the intermediate results of the cross-conjugants are due to the fact that half of the ex-conjugants descended from one parent have its characteristic fission rate; and the half descended from the other parent, its characteristic fission rate. The group as a whole would then be intermediate also. The means of the means of the two parents, 7.19 and 7.03 for the first two periods, are indeed very close to the means of the cross-bred group.

That this resemblance is not due to the possibility just suggested, is shown by figure 1. On these graphs the percentage of each group is plotted against fission totals. The first set of curves are for the first five-day period; the second set, for the second period. The broken curves represent the inbred E81a group; their curves show that the great majority (71% and 67%) of this group fell in the class having less than 5 fissions in five days. The dash-dot curves represent the inbred E40a group; their curves show that the great majority (60% and 67%) fell in the class having more than 10 fissions in five days. The solid curves represent the cross-bred group; their curves show that the peaks (41% and 58%) fell in the intermediate class having between 5 and



10 fissions in five days. The dotted curves are the means of the curves of the two inbred parents; these curves are bimodal with the two modes falling in the two extreme classes, the minimums in the intermediate class. The curve for the mean of the two parents and the curve for the cross between the two parents are thus exactly opposite in character; the low points of the cross curves fall where the high points of the parental curves are, and the high points of the cross curves fall where the low points of the parental curve are. Clearly, then, the cross-bred group resembles neither parental group nor the sum of half of each of the two parental groups. Its distribution of fission rate is characteristically intermediate between those of the parents.

The situation with respect to mortality is quite different. The mortality of the cross-bred group was almost exactly like the mortality of the inbred E40a group at every stage of the experiment, and very different from the mortality of the inbred E81a group. At the end of 20 days, the mortality among the inbred E40a group was 47.5% and among the cross-bred group, 52.6%; but among the inbred E81a group, 92.9%. Mortality of the cross-bred group is not intermediate, like fission rate, but is for practical purposes the same as the mortality of the more viable parent and very different from that of the other parent.

There is one further question of much importance which the present experiment clearly answers: Do the results of conjugation in a given type of individual depend on the genetic constitution of its mate, as well as on its own? Dr. Lynch reported our experiments which demonstrated that the results of inbreeding are characteristically different in different types of individuals, such as those of the clones E40a and E81a. We can now compare what happens when an individual of the clone E81a mates with another individual of the same clone, with what happens when it mates with an individual of the very different clone E40a.

This can be done in the following ways. Although we have no way of telling which members of the pairs of cross-conjugants came from the clone E81a, we know that one member of each pair came from this clone. So, we can find the minimum possible mean fission rate of these by averaging together the values attained by the slower members of all pairs. The average thus found may be lower than the true average of the E81a descendants in the cross-bred group, but it cannot be higher. Calculation made in this way shows that the minimum possible mean fission rate for the cross-conjugants derived originally from the clone E81a is 5.1 fissions in five days. The corresponding value for those derived from inbreeding the clone E81a was 3.8 divisions in five days. Thus, by conjugating with E40a instead of its own sisters, the mean fission rate of the descendants of E81a has been increased, at the very least, by 35%.

The difference in viability due to the same cause can be demonstrated in the following way. The minimum possible viability of the E81a members of the cross-conjugant group can be calculated by counting as survivors only those whose mates also survived. Obviously, one member of each of these pairs must have been descended from the clone E81a. We thus find that the minimum possible viability of the descendants of E81a in the cross-bred group to have been 25%. When E81a was inbred, only 3% survived. Thus, by conjugating with E40a instead of with its sisters, the viability, as measured by survival, of E81a has been increased from 3% to 25%—an increase of 2.57%.

It is thus clear that in respect to both fission rate and viability the results of conjugation in any individual depend not only on the genetic constitution of that individual, but also on the genetic constitution of its mate. This elementary and fundamental principle of protozoan genetics, though often assumed, has never before been demonstrated experimentally in ciliate Protozoa.

Note: Since the above report was made, the experiment has been repeated on two new clones with characteristics similar to the ones previously studied. In the repeated experiment, it was possible to distinguish through and after conjugation the two parents entering into the formation of the hybrids, by a clear-cut difference in size. It was thus possible to demonstrate, beyond doubt, that crossing a clone characterized by low viability and low fission rate with a clone characterized by high viability and high fission rate resulted in increasing the viability and fission rate of the poor clone and decreasing the viability and fission rate of the good clone. The result previously reported (that the effect of conjugation in a given type of individual depends not only on its own genetic constitution, but also on the constitution of its mate) has therefore been fully corroborated.

SCIENTIFIC BOOK REVIEWS

Children Who Run on all Fours. Ales Hrdlicka. xx + 418 pp. Illustrated. $5.00. Whittlesey House. McGraw-Hill Book Co.

The modern student of children has come to realize that their characteristics in both structure and behavior give at a very early period strong indications of their future personalities.

They appear to be born with their main traits already determined, their behavior already far more set than many parents realize. Much time and effort have been wasted by such adults in trying to bend the little fixed organisms to imagined ideal standards entirely unsuited to their type. Tragedies have often thus resulted.

But the key to types is not yet always easily found since variation and intermixing of traits often obscure their identities. Hence it is of special interest and helpfulness when certain children are found distinguished by an early definiteness of organization and habit, which can be tabulated and analysed.

Dr. Ales Hrdlicka first observed with surprise some thirty years ago in our western country a little Indian baby running on all fours like an animal. Since then he has seen many other cases in the course of extensive travels throughout the world, and has collected through correspondence nearly four hundred records of cases apparently well authenticated.

The attitude and behavior of these children was so unusual as to attract attention; but though a number of scientists are quoted as observers of occasional cases like these and of associated animal-like habits, the book before us seems to be the first serious attempt to bring the available, much scattered data together in systematic form with an effort at scientific estimation of their meaning.

"Children Who Run on all Fours" is a relatively small volume of about four hundred pages with almost three hundred pages devoted to the data furnished by most interesting letters and reports concerning individual children. Three hundred and eighty-seven children have been thus carefully recorded, 369 being of the white race. As the author says, these detailed first-hand accounts are found to be of much and varied interest—not mere statistics. They form the vital part of the book.

A reading of the letters leaves the impression that much more extensive studies should be carried on, extending the scope of this suggestive beginning. The first one hundred pages give a review of the field and discuss the cases arranged. In the second part, the relations of the phenomena to race, sex, heredity, general health and physical and physiological traits are discussed briefly. The variations in performance and in its appearance, as well as other animal-like habits which seem associated, are considered and there is a special section on the "mentality" of the children. Many excellent photographs are reproduced which add much of interest.

In the section on "Mentality" correlations with animal habits, musical rhythm, etc., the author touches on a variety of topics, and suggests methods and rules of value in following up and extending his studies. There seems to be overwhelming testimony rating children of this type as decidedly above the average mentally as well as physically. Dr. Hrdlicka feels we have here retained in a few modern children (the percentage not yet known) a conspicuous definiteness of neuro-motor coordination and control which was once common property. It is not an atavistic nor a degenerative phenomenon. It looks as if this extraordinarily efficient motor control is accomplished by the development of a better than usual mind already exceptionally adjusted at birth. The reviewer has been lucky in knowing two children of this type and is strongly impressed, in addition to their motor effectiveness, by their early precision and clarity of thought and expression which continues as they grow older.

The author is certainly right in his conviction of the importance of this field. It should be developed much further. There is promise of new data on inherited traits and capacities of children for guidance in the better understanding of various types.

It seems to me that the author's non-technical presentation of the cases and advice as to methods of observing should be exceptionally useful in enabling the average person to observe and record much useful data which is now lost. Parents will certainly discover through this little book a new world of interest and suggestions for dealing with their children. —Henry McE. Knower.

An Introduction to Neurology. C. Judson Herrick. Fifth Edition. Revised. W. B. Saunders Company. 1931.

All students of neurology will welcome the fifth edition of this very excellent text. It is too well known to need comment. The present edition has been carefully revised and brought up to date and maintains the high standing of the earlier imprints. —G. H. Parker.

The Collecting Net

A weekly publication devoted to the scientific wcrk at Woods Hole.

WOODS HOLE, MASS.

Ware Cattell .... Editor

Assistant Editors

Margaret S. Griffin Mary Eleanor Brown

Annaleida S. Cattell

MEMBERS OF THE CORPORATION AND THE MESS HALL

Workers at the three scientific institutions at Woods Hole receive their board at the Mess Hall for $7.00 a week. Members of their immediate families (wives, husbands or children) are also given meals at this rate.

This arrangement is held to rather rigidly, and there are people who feel that certain exceptions should be made. As things now stand, any member of the Corporation of the Marine Biological Laboratory who comes down to attend the official annual meeting of that body in August is classed as an "outsider" and charged for his meals at the rate of $10.00 a week. This holds true even though, in addition, he has come back to the laboratory to write a scientific paper in the library.

Membership in the Corporation is limited to those "professional biologists and persons who have rendered conspicuous service to the Marine Biological Laboratory." This institution should therefore welcome the opportunity of making its Corporation members feel at home when they return to the laboratory, which, in the last analysis, they own and control. A contribution in this direction would be to extend the privileges of the "$7.00 a week rate" to them.

In its office THE COLLECTING NET has some of the current magazines for sale as well as a number of new books on Cape Cod, including one entitled "Jane's Island," by Mrs. W. C. Allee.

Copies of the twelve-page reprint on "Formulae and Methods" used in the Chemical Room of the Marine Biological Laboratory (Edited by Dr. Oscar W. Richards) may be obtained in our office.

An appropriation of $750,000.00 was authorized recently for the work of the National Institute of Health by Congress. The Institute is under the administrative direction of the Surgeon General of the U. S. Public Health Service. Its purpose is defined as aiming to advance "pure scientific research to ascertain the cause, prevention and cure of diseases affecting human beings."

REVIEW OF THE SEMINAR REPORTS OF DRS. LYNCH AND SONNEBORN

DR. J. A. DAWSON

Assistant Professor of Biology, College of the City of New York

Drs. Lynch and Sonneborn have re-opened, with the aid of the improved culture technique devised by Dr. Raffel,the question of the effect of conjugation in the ciliate protozoan, *Paramecium aurelia*. Dr. Lynch's paper in general supports the earlier experimental findings of Dr. H. S. Jennings on the effects of conjugation in Paramecium. The method whereby conjugation between closely related clones of Paramecium is secured almost at will by Dr. Sonneborn is a noteworthy contribution in protozoology as it opens the field for successful genetic studies in the protozoa. It is to be hoped that some method of determining accurately the identity of the individual ex-conjugants can be devised.

DIRECTORY ADDITIONS

THE MARINE BIOLOGICAL LABORATORY

Investigators

Adams, Elizabeth prof. zool. Mt. Holyoke. Br 109. Shore (Falmouth.)

Carver, G. L. prof. biol. Mercer. Br 315. D 316.

Henderson, Jean instr. zool. McGill. Phys. Lab. Grinnell, Bar Neck.

Keefe, A. M. rector and prof. biol. St. Norbert. Bot. 5. White, Millfield.

Morgan, Ann prof. zool. Mt. Holyoke. Br 109. Shore (Falmouth.)

Sellmeyer, B L. prof. biol. Loyola. Bot 5. White, Millfield.

Speicher, B. R. grad. asst. biol. Pittsburgh. Rock 7. K 14.

Vicari, Emilia M. res. assoc. anat. Cornell Med. Br 317. H 8.

Wodon. A D. prof. zool. North Dakota State. OM 39. Dr 201.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the hole turns to run from Buzzards Bay to Vineyard Sound:

Date	A. M.	P. M.
Aug. 15	6:01	6:19
Aug. 16	6:44	7:05
Aug. 17	7:36	8:00
Aug. 18	8:23	8:58
Aug. 19	9:13	9:54
Aug. 20	10:10	10:56
Aug. 21	11:11	11:59
Aug. 22	——	12:10
Aug. 23	1:05	1:16
Aug. 24	2:05	2:09
Aug. 25	3:01	3:07

In each case the current changes approximately six hours later and runs from the Sound to the Bay.

ITEMS OF INTEREST

Dr. Calvin B. Bridges, who for many summers has been carrying on investigations at Woods Hole, has received an invitation from the Russian Soviet government to visit Russia early this fall to work on some of the agricultural problems with which the Stalin administration is faced. Dr. Bridges is a member of the Carnegie Institution of Washington and for the past three years has been working in the biology department of the California Institute of Technology. He expects to sail for Russia early in October for a four months' stay. Officially a "learned specialist," the highest post to which a scientific worker may be appointed in the Russian institutions, he will have his headquarters at the Academy of Sciences in Leningrad where he will continue his studies in theoretical genetics. He expects to deliver a series of lectures on genetics to the staff of the University of Leningrad as well as consult with workers in various agricultural stations on specific problems of plant and animal breeding.

Dr. Helen Morris received her Ph.D. in botany at Columbia University in June. The second honor that came to her this Spring was election to membership in Sigma Xi.

Mr. Seymour M. Farber, who was expecting to begin work at the Marine Biological Laboratory early in August, has just written that illness will prevent him from utilizing The Collecting Net scholarship, which was awarded to him last year. Mr. Farber plans to continue his research problem at the laboratory next summer.

Dr. Carl V. Smythe has completed his first year as a National Research Fellow in the laboratory of Dr. Leonor Michaelis at the Rockefeller Institute and has been appointed to a foreign fellowship for 1931-32. He sailed for Germany on July 2nd where he will continue his work on ferric compounds in Warburg's laboratory at the Kaiser Wilhelm Institute fur Biologie at Dahlem.

Dr. Henry B. Bigelow, director of the Oceanographic Institution, addressed the members of the Kiwanis Club of Falmouth and their guests at a lobster supper at Handy's Tavern at the end of July. He spoke on oceanographic work in general as well as about the new laboratory here.

Dr. Harry H. Charlton, who in the past has worked many summers at the Marine Biological Laboratory, has been promoted to a full professorship in the Department of Anatomy at the University of Missouri.

MT. DESERT ISLAND BIOLOGICAL LABORATORY

Dr. James Murphy and Dr. E. M. East conducted the seminar on August 5th at the Jackson Memorial Laboratory.

Dr. Warren H. Lewis delivered the fourth lecture in the M. D. I. B. L. Popular Lecture Course on Thursday afternoon, August 6th. His subject was "Cancer Problems" and was illustrated by motion pictures.

On August 7th the members of the Laboratory were entertained at the Marine Biological Laboratory at Lamoine, Me. An exhibition of specimens was given by the students. The visitors were invited to inspect the buildings and grounds. Tea was served at the dormitory.

Dr. and Mrs. W. H. Lewis entertained the Laboratory at a picnic on August 8th.

The Monday evening seminar on August 10th was in charge of Dr. William Wherry who spoke on "Biological Control of Bubonic Plague" and Professor Ulric Dahlgren whose subject was "Disease among Invertebrates."

—Louise R. Mast.

SCRIPPS INSTITUTION OF OCEANOGRAPHY

From S. J. Cook, General Secretary of the Fifth Pacific Science Congress to be held in Victoria and Vancouver, B. C., in May-June, 1932, Director T. Wayland Vaughan has just received a letter asking him to organize the program for a divisional meeting of the Physical Sciences dealing with the general subject of "Recent soundings, gravity investigations, and mapping of sea floors."

Last week Dr. O. T. Black, Biochemist in the Bureau of Plant Industry of the U. S. Department of Agriculture, arrived at the Institution to make use of its Laboratory facilities for some special investigations which he has in hand, in collaboration with Dr. W. T. Swingle. The primary object of these investigations is to find plants favorable for producing certain kinds of chemical substances (e. g., certain kinds of drugs) in commercial quantities and to increase production in others.

Dr. F. S. Brackett, Chief of Division of Radiation and Organisms in the Smithsonian Institution at Washington, D. C., visited the Institution last week. He was especially interested in the work of Mr. Burt Richardson on penetration of light into sea water and in investigations on solar radiation. He was accompanied by Dr. W. T. Svingle of the U. S. Experimental Date Farm at Inyo, California.

THE WOODS HOLE LOG

THE CHORAL CLUB CONCERT

The program presented Saturday evening, August 8, was a glorious treat to the largest crowd that has thus far attended a Choral Club Concert. To critique such a performance is not easy.

Opening with a feeling of restraint that showed more lack of confidence than of training, the first number was perhaps the weakest on the program. One could see the audience settle itself for "another one of these programs" and polite applause.

Then came a surprise. The masterly "Cherubim Hymn" of Musitcheskoo, in its dramatic intensity, swept the singers out of themselves and caught up the audience as well in its enthusiasm. Whether the rounds of applause were due to familiarity with this number and unfamiliarity with its predecessor is an open question. To one hearer, at least, Kastalsky has always seemed more or less ineffectual. This is especially evident when one compares the opening number of the program with the stirring setting given it by Ivanoff.

The Gretchaninoff number, a sort of abbreviated "credo," was smoothly rendered and interesting by reason of its recitative quality. It was followed by Handel's "Then Round About the Starry Throne," reminiscent. in its contrapuntal passages, of Bach, and quite as effective.

As encore for the first section of the program, "Gospodi Pomiluy," the hymn from the Good Friday Service of the Russian Liturgy, won instant favor. It is sometimes rendered at a less speedy tempo, but the ritual melodies of the Orthodox, as well as the Latin church, are susceptible to a wide variety of interpretations—and that is the affair of the Director, not the audience.

The second part of the program opened with three more numbers from Handel. The first and third were characteristic of the early attempts to graft English words on an Italian operatic style, and consequently pleasant to hear but, in countless repetitions, utterly unhappy as to sense. The second number, a serenade, was much better and the singers showed themselves more at ease.

Another high spot on the evening's program was the "Wassail Song." Here was music which both audience and singers understood, appreciated and took unto themselves. A picture of Yule in old England with carollers heard in the distance, approaching, singing their good wishes and going on into the distant silence—and its naivete increased its hold on the imagination.

The last two numbers by Arkhangelsky were pleasing revivals from previous years. Different alike in thought and melodic theme, they were, in the faultless rendition by the club, characteris- music, like Schumann's, is noted for its descriptive power.
tic examples of the great Russian genius whose

That Mr. Gorokhoff continues to return to Woods Hole is a tribute to his public spirited interest in our scientific colony. It is, likewise, a tribute to the spirit of cooperation shown by the Choral Club members. Without their regularity at rehearsal and fine feeling for interpretation, the efforts of any director would be wasted. Nor can the intelligent assistance of Mrs. Moser, Schweitzer at the piano be overlooked. She is one of those rare accompanists who really accompany and do not lead.

It is to be hoped that Mr. Gorokhoff will continue to make the Woods Hole Choral Club the exponent of the choicest Russian music and that he will continue to vary his programs with numbers from the old and modern English music, not only of Vaughn Williams, Holst, and Gilbert and Sullivan, but also from William Byrd, Orlando Gibbons and the rest of that group which made Elizabethan England a "nest of singing birds."

—DR. A. M. KEEFE.

On Saturday night, August 8th, the Coast Guard burned and sank a rum boat ten miles off Vineyard Light, after a hard chase. The Eaglet, an eighty-foot craft from Tiverton, R. I., had long been under suspicion. The CG-813 sighted and hailed her, and when she increased her speed, fired a shot across her bow. The Coast Guard then opened fire with the machine gun, wounding three of the Eaglet's crew and puncturing her fuel tank. The seven members of the crew and nine cases of Canadian liquor were rescued before the boat finally burned and sank. The crew, who had on board about 1500 cases of liquor, have been turned over to the police in New Bedford for arraignment in the Federal Court.

On Monday afternoon, August 10th, the Woods Hole Yacht Club again held races. The winners were: Morris Frost in his baby knockabout, "Windward;" Wistar Meigs in his dory, "Aunt Addie;" and Philip Woolworth in his catboat, "Lurline."

This past week, the University Players have reached a high point in both acting and production in Ferenc Molnar's satiric little play, "The Guardsman." Elizabeth Fenner as the actress-wife displayed an even greater versatility and charm than usual and Kent Smith proved himself both a good actor, and an adept at foreign accents. Next week the Theatre at Silver Beach will present "Juno and the Paycock," by the gifted Irish dramatist, Sean O'Casey. —M.S.G.

THE COLLECTING NET

Vol. VI. No. 9. SATURDAY, AUGUST 22, 1931 Annual Subscription, $2.00
Single Copies, 25 Cts.

PHYSIOLOGY OF THE CORPUS LUTEUM AND ITS INTERGLANDULAR RELATIONSHIPS

Dr. F. L. Hisaw

Professor of Zoology, University of Wisconsin

Three physiologically active substances, in addition to oestrin, are secreted by the corpus luteum of the sow. One, relaxin, produces relaxation of the pelvic ligaments of the guinea pig characteristic of the normal condition which exists during pregnancy. A second substance, a mucifying factor, modifies the vaginal mucosa of certain rodents, e. g. rats and mice, into a mucus secreting type. The third hormone, corporin or progestin, has a specific action on the uterus, causing such uterine responses as the development of decidual tissue, formation of the pseudopregnant condition in the uterus of rabbits and the development of a premenstrual endometrium in the uterus of monkeys. Other physiological effects, such as the inhibition of the oestrous cycle and the inhibition of uterine (*Continued on Page* 230)

M. B. L. Calendar

TUESDAY, AUG. 25, 8:00 P. M.

(1) Dr. Paul S. Henshaw: "Recovery from X-ray Effects as Observed in Arbacia Eggs." (10 minutes)

(2) Mr. Ware Cattell: "The Reaction of the Fundulus Ovum to the Direct Electric Current." Motion Pictures (15 minutes)

(3) Dr. E. A. Wolf and Dr. H. H. Collins: "The Effect of Ultraviolet Radiation upon the Color Pattern of Triturus. (12 minutes)

(4) Dr. G. H. Parker: "The Discharge of Nematocysts." (15 minutes)

FRIDAY, AUG. 28, 8:00 P. M.

Professor J. H. McGregor: Motion Pictures taken in the Belgian Congo and the Cameroon by the African Expedition (1929-30)

THE PACIFIC BIOLOGICAL STATION IN NANAIMO, B. C.

Dr. W. A. Clemens

Director of the Station

The Pacific Biological Station is located on Departure Bay, Vancouver Island, four miles from the city of Nanaimo, B. C. It is one of four stations operated under the auspices of the Biological Board of Canada, which in turn is under the control of the Minister of Fisheries of the Dominion.

The Biological Board came into being in the year 1898 following representations made to the Government by prominent British and Canadian biologists on behalf of the British Association for the Advancement of Science and the Royal Society of Canada. The first Station was established on the Atlantic coast in 1899 and the Pacific Station in 1908. The Biological Board as at present constituted consists of representatives from practically all of the universities of Canada, three representatives from the Department of Fisheries and two representa-

TABLE OF CONTENTS

THE LABORATORY BUILDINGS,

WHICH ARE EQUIPPED WITH RUNNING FRESH AND SALT WATER AS WELL AS WITH GAS AND ELECTRICITY

tives from the fishing industry. Few organizations, if any, have had a greater influence in the development of research in Canada than has the Biological Board. It has drawn to its problems most of the best trained biologists of Canada and in recent years, leading chemists and physiologists. It has interested the universities in marine problems and has given them a field for study and research, and undoubtedly this has contributed to the breadth and high quality of the instruction given in them. It has provided an opportunity for young men and women to become acquainted with marine biological problems, to gain experience in research and, at the same time, to obtain a practical, as well as philosophical, outlook.

Perhaps the primary function of the Pacific Biological Station may be said to be the supplying of information which shall make possible the intelligent conservation of the aquatic resources of the Canadian Pacific coast. This is a wide field in that any information concerning the ocean or the fresh waters and their contained life is of some value. However, there are certain problems which can be attacked in such a way as to yield results of more or less immediate application and our program gives special attention to these, but at the same time provides for investigations of a fundamental character. Naturally, chief attention is given to fishery problems.

The work of the Station is entirely investigative, no instruction being given. The investigations are carried out by two sets of workers, namely, by a resident staff and by members of the staffs and post-graduate students of universities working during the summer months and completing investigations and reports after return to university duties and studies. The permanent staff as at present constituted consists of eight men in addition to the Director. The number of voluntary investigators and temporary assistants ranges in a season from twenty to thirty, located at the Station and in the field. The laboratory accommodation consists of three buildings, two given over to biology, administrative offices, library and museum, and the third to chemistry. The laboratories are equipped with gas, electricity, fresh and salt water and general apparatus and supplies for biological, chemical, physiological and oceanographical investigations. A sixty-foot motor boat, equipped with a winch, dredges, nets, water bottles, etc. provides for field work. In addition, there are two smaller motor boats and row boats. Living accommodation is provided in a large residence building. While the Station serves as headquarters and a great deal of the research work is carried out there, much of the work is actually done in the field with centers of activity scattered along the whole coast line and even in the interior of the Province of British Columbia.

Some of the major problems occupying our attention at the present time are as follows:

Pacific Salmon. At Cultus Lake, a sub-station, known as the Pacific Salmon Research Station, has been established where, under the direction of Dr. R. E. Forester, a comprehensive study of the propagation of sockeye salmon is being carried out. Here relative efficiencies of artificial propagation with fry planting and egg planting are being determined in comparison with natural propagation. The value of retention of fry in ponds for various periods is being studied. Carefully controlled experiments to determine the possibilities of transplantation from one area to another are being carried out. Various hatchery practices are being investigated. Special studies of the causes of mortality during egg and fry stages have been instituted.

On the Queen Charlotte Islands a study is being made of the life-histories and propagation of

EXPERIMENTAL FISH PONDS

AT A SUB-STATION KNOWN AS THE PACIFIC SALMON RESEARCH STATION

pink and chum salmon by Dr. A. L. Pritchard. The investigation involves the enumeration of spawning adults and seaward migrating fry.

During the past five years a comprehensive salmon tagging program has been carried out for the purpose of determining the migration routes of the various species. The results from the tagging of spring salmon have been particularly successful and illuminating, revealing an extensive movement southeastward all along the coast even to the Sacramento river in California.

Pilchard-Herring. The problems in connection with these fishes are being attacked chiefly by statistical studies of catches and samplings of catches, supplemented by certain biological researches. The work is under the direction of Dr. J. L. Hart, with Messrs. R. W. Whittaker and A. L. Tester as assistants.

Shellfish. Various biological investigations are being carried out on crabs, prawns, clams, and oysters. Special attention is being given to the propagation of oysters, of which three species now occur in our waters, namely, the native, the introduced eastern and the introduced Japanese. The work in this field is in charge of Mr. C. R. Elsey.

Trout. The trout constitute a very valuable resource in the Province of British Columbia. The investigation has been initiated by a thorough taxonomic study and has been followed by studies of general life-histories, natural and artificial propagation and the productivity of various lakes. Mr. C. McC. Mottley is in charge of the investigations.

Oceanography. A detailed study of the oceanographical conditions existing in the Strait of Georgia is being carried out under the general supervision of Dr. A. H. Hutchinson, of the University of British Columbia. The physico-chemical phases are now being determined by Dr. N. M. Carter, of the staff of this Station. The Strait presents a very complex set of conditions because of the extensive tidal movements and the inflow of very large quantities of fresh water, particularly from the Fraser river. It has been found that the water from the Fraser river forms an extensive stable surface layer which takes up heat and as a result the waters of the Strait have a relatively high summer temperature as compared with the outside waters. High phosphate, nitrate and silicate values have been found. Certain areas are exceedingly productive of plankton, and the productivity of this body of water in relation to the peculiar physico-chemical factors forms a very intricate and interesting study.

General. The region in the vicinity of the Station is exceedingly rich in plant and animal life and offers an excellent field for investigators in general biology, ecology, experimental zoology, taxonomy, morphology, general physiology, biochemistry, etc. While investigators coming to the Station are expected to undertake studies of more or less economic significance, they have not been entirely limited in this respect, for it is realized that any advance in the knowledge of the ocean and its life is of value in the consideration of the general economy. The following partial list of researches now being carried out or recently conducted will indicate something of the range of activity.

Diatoms in the food of oysters; The significance of diatoms in the food of Copepods and Schizopods; Life-histories of Copepods; The early stages in the life-histories of crabs; The reactions of fishes to loud noises; The Protozoa of British Columbia waters; The life-history of the ling cod; The development and growth of scales in steelhead and cutthroat trout; A study of quantitative methods for the collection of plankton; The productivity of lakes; Symbiosis among marine organisms; Systematic studies of Polychaetes; The relation of seafowl to fishes; Cestode parasites of Pacific fish; Creatin and creatinine content of fish muscle and body fluids; Nitrogenous metabolism in the dogfish; Physiological and pharmacological studies of fish gut.

Each piece of research carefully and thoroughly carried out is a welcome contribution in a field at once extensive and complex, and so intimately associated with the welfare of mankind.

THE TORTUGAS LABORATORY

W. H. Langley

Executive Officer of the Laboratory

It was by authority of the Carnegie Institution of Washington, which has since maintained it continuously, that the Tortugas Laboratory was established by Dr. Alfred Gillayor in 1904. It stands on the westernmost of the Florida Keys, far out in the Gulf of Mexico, seventy miles west of Key West, itself one hundred and forty miles distant from the Florida mainland.

This choice location was determined by several factors. Among these, the richness of the local marine fauna, which attracted the attention of Alexander Agassiz as early as 1878, should probably be given first place. Its influence is powerfully supported, however, by the purity of the ocean water bathing the shores of its islands, and bytheir freedom from all endemic tropical diseases.

In 1904 the fact that, in the interest of the garrison then stationed at Fort Jefferson on Garden Key—four miles from Loggerhead Key, the site of the Laboratory — government boats maintained frequent communication with Key West, seemed an additional advantage, but when the garrison was withdrawn, it proved an easy matter to adjust the life of the station to the changed condition. Enforced isolation proved a benefit in disguise. It permits and encourages concentration upon research unembarrassed by the restrictions of convention or the interruptions of casual social activity.

The station is open at present each summer for twelve weeks, beginning its season about the first of June. Twelve to fourteen men may be comfortably accommodated at once in its two laboratories, one of which is 20 by 50 feet in length with a wing, 20 by 30 feet, housing aquaria supplied with running sea-water reaching them through a lead distribution system. The other is 20 by 58 feet with a sleeping porch 14 feet wide surrounding it on three sides. One of these buildings includes a photographic dark room and a larger light proof room for experimentation. The services of eight skilled workmen, the resources of a rather well-equipped machine shop, and a fleet of boats meet the requirements of investigators.

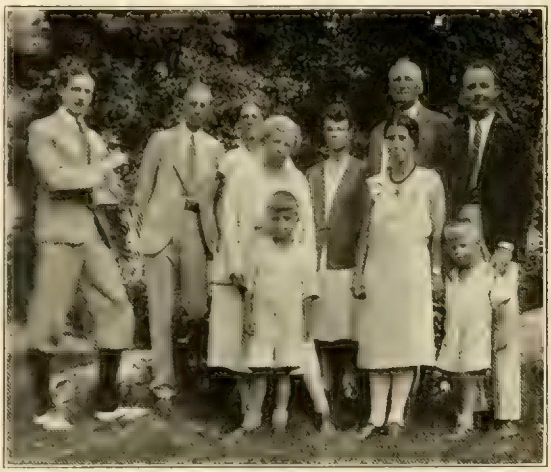
The *Anton Dohrn*, seventy feet long, eminently seaworthy, with two fifty-horsepower engines, and capable of nine knots per hour, maintains communication with Key West at fortnightly intervals. She is also provided with equipment for dredging to the depth of three hundred fathoms. The launches *Velella* and *Darwin*, respectively capable of making eight and twelve knots per hour, provide adequate transportation or for collecting expeditions within the group and for shallow water dredging. Smaller boats are available as needed.

A Delco lighting plant permits night work. Cypress tanks with a capacity of twelve thousand gallons store fresh water in quantities sufficient for every reasonable need. There is an adequate cold storage system for fresh meats, perishable vegetables, etc. The table is in charge of an unusually competent steward. By courtesy of the Superintendent of Lighthouses, Seventh District, communication with the outside world by telephone and telegraph is possible.

Admission to the laboratory is by invitation. In general, place may be found only for investigators of some experience whose problems may be studied at Tortugas with especial advantage. A place as assistant is sometimes open to a younger man of unusual promise. The equivalent of transportation from New York to Key West and return, when the necessary costs of travel are so great, is made available to each investigator. The institution bears the usually moderate cost of special apparatus for research. There are no charges of any sort for maintenance, service or the use of the laboratory's facilities.

One advantage the station possesses in greater degree than most others is a direct result of its geographical location. It is possible to work all day long, if necessary, in the warm water about it, and to use a diving hood for hours without discomfort in the study of marine animals, undisturbed in their natural surroundings. The moat about Fort Jefferson and a tern rookery within the Tortugas group increase the range of possible studies. But, for biology as a whole, these advantages are all slight in comparison with the opportunity the laboratory gives to northern workers to see a marine flora and fauna very different from that they know best. Even superficial contact with the species of a strange region enormously enhances the value of the home fauna and flora as materials for study.

During the current season the following investigators have worked or will work at the laboratory: P. Bartsch, U. S. National Museum: Experiments with Cerious; W. E. Bullington, Randolph-Macon College: Movements of Ciliate Protozoa; L. R. Cary, Princeton University: The Cultivation of Invertebrate Tissues in Vitro; John Colman, Cambridge University, England: Eco-



YALE AT MOUNT LAKE BIOLOGICAL STATION IN VIRGINIA

J. M. Valentine; L. L. Woodruff; Mrs. Valentine; Mrs. Woodruff; Mrs. G. E. Hutchins; Mrs. Burns; A. Petrunkevitch; Robert Burns, and his two children.

logical Studies in Marine Zoology and Investigation of Coral Reef Structure; C. Hartman, Carnegie Institution: The Hypophysis in Fishes; W. N. Hess, Hamilton College: Photoreceptors and Reactions to Light in Balanogossus, etc; D. L Hopkins, Duke University: The Life Histories and Physiology of Marine Amebae; B. W. Kunkel, Lafayette College: Differential Mortality in Hermit Crabs Exposed to Unfavorable Conditions; W. H. Langley, Goucher College: Observation in Fishes; H. W. Manter, University of Nebraska: Systematic Study of Tortugas Trematodes: H. S. Pearse: Migration of Organisms from Sea to Land; W. L. Schmitt, U. S. National Museum: Systematic Study of Decapods and Submarine Motion Photography; R. G. Stone, University of Missouri: Influence of Radium on Regeneration in Annelids; G. Tandy, British Museum Natural History: Ecological Studies upon Marine Algae, and Studies of Coral Reef Structure; J. P. Visscher, Western Reserve University: The Barnacles of Tortugas with Special Reference to their Larvae; S. Yamanouchi, University of Chicago: Life Histories of Marine Algae.

THE MURMANSK MARINE BIOLOGICAL STATION

Dr. Dmitry N. Borodin
Independent Investigator, Yonkers, N. Y.

Murmansk Marine Biological Station is located near Ekaterininskaya harbor, Alexandrovsk, a town on the northern shore of the Kola peninsula, near Norway, Russia. The geographical position of this marine biological station is unique. Being located at 69°15′ N. latitude and 33°30′ E. longitude Greenwich, it is the northernmost scientific institution in the world and the only station located about one degree above the polar circle. The ocean near the Station never freezes and the harbor is free from floating ice, like the entire Murmansk coast all the year around as far as Cape Sviatoy Noss in the East. This is one of the numerous Russian paradoxes; other harbors which are located farther south, like Arkhangelsk on the White Sea, Leningrad on the Baltic, Astrakan on the Caspian, Vladivostok on the Pacific, as well as Odessa on the Black Sea, are frozen and closed for different lengths of time in the winter. Before the war it was possible to reach the Murmansk Biological Station only by a steamer from Arkhangelsk; but at present a railway delivers one to Murmansk, a large port and a vivacious town in the Kola fjord, and from there a steamer takes one to Alexandrovsk.

From May to July there are no nights at Alexandrovsk, and the work at the laboratory can be continued for twenty-four hours without artificial light. To those "white nights" one must become accustomed, for to keep a record of the calendar dates and week days is entirely useless. The economy in electricity which is thus effected in these polar regions is only temporarily apparent, for the "black days" of fall and winter, when there is no sun and no daylight at all, but only moon and an aurora borealis succeed the "white nights".

The Station has four buildings. One of them has laboratories, a library with a complete set of "Reports on the Scientific Results of the Exploring Voyage H. M. S. Challeger 1873-73", a dining room, and aquaria in the basement. A second building serves as dormitory and abode for the staff; the third building is an electrical station, and the fourth a dry dock and workshop.

The Station has for its use a good two-masted, gasoline motor yacht, "Alexander Kovalevsky" and many other boats of Norwegian "jolas" type, as well as Russian "shniakas", which resemble the ancient ships of Norsemen and Vikings.

From May or June, when the steamer brings the first group of students and professors, until the end of the season, the Station is full of activity. Russian universities of the North are usually well represented.

The ocean in the vicinity of Murmansk Station has an exceedingly rich fauna of invertebrates and vertebrates, whales being included in the latter phylum. Among the Polychatea the following are common: *Lepodonotus squammatus, Phyllodoce maculata, Lumbrinereis fragilis, Nereis pelagica, Ammotrypane aulogaster, Arenicola marina, Spirorbis borealis*, and many Sabellidae; and among the Chloraemidae are *Brada granulosa B. granulata, Trophonia plumosa* and *Flabelligera affinis*. Nemertines are well represented and some of them attain a large size. Very common are *Lineus gesserensis, Amphiporus lactiflores*, and *Cephalotria. Echiurus pallasi* and *Priapalus caudatus* are always ready for student use.

Molluscs are easy to obtain, and they include *Littorina litorea, L. rudis, L. pallida, L. obtusata, Mya truncata, Mytilus edulis* and *Pecten islandicus*.

An enormous quantity of sea-urchins is usually consumed by investigators; they belong to a local species, viz., *Strongylocentrotus droebachiensis, Asterias rubens, Ophiura sarsi* and *Ophiopholis aculeata* are other local echinoderms.

Balanoglossus meeschkowskii, that classical object of study, is also present.

The oceanic flora of algae consists of large *Laminaria sacharina* and other species which may be found in the deep fjords. When the water re-

cedes at low tide the algae *Lithothamnion glaciale, L. ungeri, L. soriferum,* and *L. nodosum* form a pretty pink and magenta border to the shore. Other species of algae are *Porphyra laciniata, Phyllophora elongata, Hildebrantia prototypus, Rhodomela lycopoides, Corallina officinalis, Ascophyllum nodosum, Lithoderma, Nemolion lubricum and Ficus serratus, F. vesculosus, F. filiformis ano, F. inflatus,* and many others.

The author remembers as his co-workers of the summer of 1909 Professors V. A. Dogiel, Protozoa, A. A. Zawarzin, morphology of the nervous system of insects, K. M. Derjugin, fauna and ecology, K. K. Kluge, director of the Station, and a group of students from two universities. During that summer the author collected material for comparative histology of polychaete worms and also carried on experiments on their physiology. Part of the written, unpublished reports disappeared during the Russian troubles, but some of it was saved by his colleagues and recently discovered in Vladivostok.

PHYSIOLOGY OF THE CORPUS LUTEUM AND ITS INTER-GLANDULAR RELATIONSHIPS

(Continued from Page 225)

contractions which are known to be due to the corpus luteum can be demonstrated by the use of extracts, but the specific hormone response is not known.

Relaxin. This hormone, in addition to being present in the corpus luteum, may also be extracted from the blood of several species of mammals during pregnancy. It is also present in amniotic liquor and the placenta. A single subcutaneous injection of relaxin into a virgin guinea pig during full oestrus produces relaxation of the pelvic ligaments within eight to twelve hours. Usually the amount of hormone obtained from one gram of corpus luteum tissue of the sow is sufficient to produce a positive result. This hormone can affect changes in the pelvis only when the animal is under the influence of oestrin. The pelvic ligaments of a castrate female do not respond to relaxin unless the animal is first put in the proper physiological condition by the administration of oestrin. The symphysis pubis of a normal male guinea pig cannot be relaxed due to the fact that it differs anatomically from that of the female. This condition can, however, be changed to the female type through feminization by oestrin or ovarian grafts, after which relaxation can be produced under the same conditions as described for the female.

Relaxation is the result of a combined action of oestrin and relaxin. It is a "one-two" reaction in which oestrin must act first, followed by relaxin. The relationship between oestrin and relaxin is a qualitative one, that is, large doses of oestrin do not seem to inhibit or intensify the action of relaxin.

The mucifying hormone. The vaginal mucosa of rats and mice is changed during pregnancy to a mucus secreting type which apparently serves to lubricate the birth canal at parturition. This development can be produced in castrate animals by corpus luteum extracts and is due to a specific hormone which, as far as known, takes part in no other reaction. Though the complete distribution of this substance is not fully known, it has, however, been extracted from other tissues such as foetal membranes and also from urine. The mucifying hormone acts in conjunction with oestrin in producing its effect. The vaginal mucosa must first be built up by oestrin before the mucifying substance can act. This is then also a "one-two" reaction in which oestrin must precede the mucifying factor, but the relationship between the two hormones is a quantitative one in that oestrin in sufficient doses to produce oestrum prevents the action of the mucifier.

Corporin. A third hormone of the corpus luteum, corporin or progestin, promotes such reactions of the uterus as development of decidual tissue, formation of the pseudopregnant condition in the uterus of rabbits, preservation of young in the uterus after castration, and the formation of a premenstrual endometrium in the uterus of castrate monkeys. The physiological factors governing these uterine reactions seem to be the same, and so they can be illustrated by one or two examples.

(1) The pseudopregnant or progestational condition in the uterus of rabbits depends on a quantitative balance between oestrin and corporin. The reaction may be thrown in either direction by dosage, that is, a large dose of oestrin will mask the action of a small dose of corporin, while the reverse is also true. (2) A subthreshold dose of oestrin aids the action of a threshold dose of corporin when the treatment is continued for a long period. (3) A given dosage of oestrin may mask the action of a given dosage of corporin, but if the dosage of corporin is increased the same amount of oestrin does not inhibit corporin but enables corporin to preserve the progestational picture longer than it otherwise could if given alone.

(1) Neither corporin or oestrin when given alone can produce a typical premenstrual endo-

metrium in the uterus of castrate monkeys. (2) The follicular hormone (oestrin) must first promote growth of the endometrium and the corpus luteum hormone (corporin) modifies this structure into the premenstrual condition. (3) It is a "one-two" reaction in which the two hormones must have a quantitative relationship to each other. (4) Oestrin inhibits menstruation, while corporin does not. (5) Oestrin may be injected in large doses (100 rat units or more daily) for long periods (over 30 days) without producing menstruation, but bleeding is precipitated if the dosage is lowered materially or discontinued. This bleeding, however, is not from a typical premenstrual endometrium but is due to necrosis of an endometrium of a follicular hormone type. (6) Oestrin stimulates mitotic activity in the uterine glands while corporin does not. (7) Corporin produces swelling of the cells of the uterine glands, contributing, we think, to their coiling.

The three hormones which have been extracted from the corpora lutea of the sow produce specific physiological reactions which can be used as end points for their quantitative standardization, and as they are chemically different it is possible to isolate them by chemical procedures.

OSCILLOGRAPHIC STUDY OF THE CARDIAC GANGLION OF LIMULUS POLYTHEMUS

Dr. Pierre Rijlant

Professor of Physiology, Solvay Institute for Physiology, University of Brussels

Indirect evidence as to the neurogenic origin of the heart beat in *Limulus polyphemus* has been brought out by Carlson (1904). Studying the electrocardiogram of Limulus obtained with a string galvanometer, Hoffman (1911) showed the oscillatory character and supposed that this was due to an oscillatory discharge of the ganglion, tetanizing the heart muscle. Garrey (1912) verified the findings of Hoffman and studied the modification of the normal oscillatory activity under the influence of changes in temperature and of drugs; he does not. however, consider the contraction of the heart of Limulus to be of tetanic character. But Nukada (1918), working on the heart of *Limulus longispina* could not find, in normal condition, an oscillatory discharge and described an electrical activity similar to that of the heart of vertebrates. Hoshin (1925) and Dubuisson (1930) agreed with this conception and more recently Monnier and Dubuisson, using a cathode ray oscillograph similar to the one of Erlanger and Gasser. They also admitted that the origin of the heart beat was not in the cardiac ganglion but in the muscle itself and that, under normal conditions, no conduction could be detected, the heart contracting simultaneously in all its parts.

The disagreement between physiologists as to the neurogenic or myogenic origin of the heart beat in Limulus is due to the fact that no direct evidence whatever has been brought as to the spontaneous activity of the cardiac ganglion. There is even disagreement as to the nature of the electrical wave in the heart muscle. This is due to the low value of the action potentials in Limulus. No string galvanometer can record the potentials accurately, and the cathode ray oscillographs used were not adapted to work on a spontaneous reacting tissue.

For these reasons I made a cathode ray oscillograph outfit (autumn, 1930) giving continuous records at constant speeds which can be adapted between one and five hundred centimeters per second, and having a sensitivity up to one microvolt for two millimeters' deflection. For the actual experiments a sensitivity of five microvolts per millimeter is used with a balanced amplifier, resistance coupled, amplifying 560,000 times. The experiments on Limulus were performed either in the Solvay Institute for Physiology in Brussels, on Limulus sent over in the Spring of 1930 from the Woods Hole laboratory, or in the Marine Biological Laboratory this summer.

The records obtained show the oscillatory character of the electrocardiogram of Limulus; usually a very important initial wave followed by ten to thirty small waves are obtained, the whole length of the complex being 1.2 seconds. When the vessels are tied off or the heart is distended by blood or air, this activity is superimposed on a very slow single wave analagous to the well-known "deformation potential" in any living system irregularly distended. This corresponds, corrections of their records being made, to the findings of Hoffman and Garrey. Lack of sensitivity in their methods prevented Nukada and Dubuisson from finding oscillatory oscillograms.

In some experiments on intact animals it is possible to show an electrical activity independent of the heart activity but of the same average rhythm. This is probably due to the activity of the auricle commonly called pericardium in Limulus.

To study the pace-maker in the heart two cathode ray oscillographs are needed, the deflections being registered simultaneously on the same film. Two pairs of independent electrodes are connected to the tissue in experiment, the potentials amplified through amplifiers and sent into two cathode ray oscillographs. When one oscil-

lograph registers the activity of the cardiac ganglion and the second one the activity of the muscle, under all conditions the nervous activity starts before the muscular activity. Nowhere is it possible to find a muscular region active before the corresponding part of the ganglion becomes active.

Hoffman, Nukada, and Garrey made unsuccessful attempts to register the activity of the ganglion. A few months ago, Heimbecker described an action potential in the cardiac ganglion of Limulus as "scattered volleys of low potential which increase in frequency, number and amplitude." That description does not correspond in any of its points to the action potential of the cardiac ganglion of *Limulus polyphemus* and is due to the fact that the method used by that author does not give objective information about complex waves starting spontaneously.

When the cardiac ganglion is completely isolated from the body and connected to the oscillograph, periodic changes in potential lasting 1.2 seconds and separated by periods of quiescence of 2 seconds are observed. Each of these potential changes is composed of a series of waves. Three different types of activity are obtained: 100 to 200 fast waves; 10 to 30 slow waves; or simultaneously fast and slow waves. The maximum action potential obtained is 150 to 200 microvolts while the normal value is 100 microvolts.

Under normal conditions the activity starts in the region corresponding to the fifth segment and is conducted up and down the ganglion at an average speed of 75 centimeters per second. This agrees with the measurements of Carlson, Edwards and Pond. Both rapid and slow waves are conducted throughout the whole ganglion. These experiments show that the ganglion activity is not due to a reflex stimulation by distention of the muscular part of the heart, as there is no muscle present in these experiments, but to a local nervous automatism.

In a further series of experiments I have studied the neuro muscular junction; the ganglion is completely dissected out with the first muscular segment remaining attached, the other segments being destroyed. Electrodes are put on the muscle and on the nerve in the second segment and connected to two oscillographs. The records show that the action potential appears in the nerve 50 *s* * before it starts in the muscle. Corrections being made for the conduction time in the nerve between the leading off electrodes and the neuromuscular junction, the delay at that junction is about 30 *s* under normal conditions but can increase to 200 *s* before complete block occurs. Curare (1%) does not affect the junction, but strychnine and ephedrin produce block. A rise in temperature decreases the delay at the junction.

Stimulation of the isolated ganglion by single induction shocks produces either single waves or oscillatory waves. Small stimuli produce single waves; two types are observed: either of short duration ‡ * 10 *s* or of long, up to 80 *s*. The oscillatory waves are made by slow or fast waves or by both. When threshold break shocks produce an oscillatory wave, the corresponding make shocks produce either a single wave or a very short oscillatory complex. The length of the oscillatory complex increases with the strength of stimulus to a limit equal to the length of a normal spontaneous complex, but decreases when the interval between stimulus and the preceding beat decreases. The absolute refractory phase for the production of an oscillatory discharge is about half the normal length of a discharge, the relative refractory phase, as regards the length of the complex lasts about two seconds. The height of the oscillatory wave does not change when the strength of stimulus is modified; the height of a single wave is proportional to the stimulus up to a limit. The refractory phase for single waves is very short and less than five *s*. At frequencies of stimulation of 100 D. V. per second signs of fatigue appear and the height of the single waves, either fast or slow, diminishes.

Single waves can be obtained without disturbing the normal spontaneous rhythm of the ganglion. Oscillatory waves delay the following spontaneous beat. Similar results can be obtained when the efferent electrodes are put on the muscle and the stimulus applied to the ganglion. These experiments show that the ganglion has two different types of nerve fibers, one giving fast waves, the other slow waves. It shows, also, that when certain ganglionic cells are stimulated the waves become oscillatory. This seems to indicate that besides the slow and fast motor nerve fibers the ganglion contains "cells of association" responsible for the oscillatory discharge.

When conduction is impaired so that ganglionic cells become isolated from the central part of the ganglion, a new automatism arises. The rhythm is very regular. Single waves appear at a constant speed varying in different experiments from 50 to 900 per minute. The smaller the group of cells, the higher is the speed obtained. When conduction changes, these isolated beats can be gradually mixed up with the normal slow complex. It is possible to show progressive passage from the normal oscillatory wave to the rapid single wave. A single wave can determine in a group of ganglionic cells the start of a new impulse which will travel in a direction opposite to the initial wave. These reflected waves can occur either at isolated

* *s* This symbol indicates "sigma".

* This symbol indicates "plus or minus."

groups of cells in the anterior segments I or II, or in the central segments. Any of these waves can be conducted to the muscle and determine a corresponding action potential in it. Slow waves produce slow potential in the muscle, fast waves fast potential changes in muscle. This indicates that there are probably two distinct muscular systems in the heart of Limulus, one slow and one fast. Nukada has described the microscopic structure of two muscular systems in the heart of Limulus.

In a last series of experiments I have tried to investigate why the ganglionic activity is oscillatory. When electrodes are put on the isolated nerve in segment V (pace-maker) and in segment II, the two waves obtained are similar. If between the two pairs of electrodes the nerve is modified either by compression or by drugs, the activity of segment V is not modified, but the waves obtained in segment II are progressively modified. If the initial complex showed 100 fast waves and 15 slow waves, the fast waves progressively diminish in number, the slow waves diminish in amplitude. Conduction can be modified so that only one fast wave, the first one, is conducted. At that moment the nerve cells in segment I start beating spontaneously at their own fast rhythm. This shows that the whole normal complex arises in the center of the ganglion and is conducted to the periphery. It also shows that the normal complex inhibits the fast automatism of isolated ganglionic cells.

In one single ganglion two or more oscillatory waves of normal shape and length can exist simultaneously without modifying one another, and be conducted to some extent. When conduction is slightly modified in the ganglion, different centers of automatism, elaborating a complete normal complex, can exist simultaneously. The intricate form of the oscillogram of the cardiac ganglion of Limulus is not due to the ganglion as a whole but to some of its ganglionic groups. I assume that in the ganglion there are different systems of association cells, each of these being able to elaborate a normal complex and to inhibit the fundamental fast automatism of the isolated ganglion cells. By the action of drugs it is possible to isolate in each of these complexes the slow and fast waves, which indicates that either the fast or slow motor components can be inhibited without modifying the characteristics of rhythm and duration of the association complex and corroborates our working hypothesis. In the cardiac ganglion of Limulus, frequency and length of the spontaneous activity are regulated by a *system of association cells* independent of the activity of the slow and fast motor cells.

SURFACE TEMPERATURE AND THE RADIATION OF HEAT FROM THE HUMAN BODY

Dr. Eugene F. DuBois

Professor of Medicine, Cornell University Medical College, Medical Director, Russell Sage Institute of Pathology.

It is generally stated in the literature that the white human skin acts almost like a perfect black-body radiator and that the amount of heat radiated from the surface can be used as a measure of the surface temperature. Some work on malarial chills performed in association with D. P. Barr in 1917 led us to doubt both of these assumptions. Last year Drs. W. S. McClellan, H. M. Halcro Wardlaw and the writer investigated this subject using the respiration calorimeter of the Russell Sage Institute of Pathology. The calorimeter determines the heat lost by vaporization by collecting the water vapor in a sulphuric acid bottle. The heat lost by radiation, convection and conduction is all collected by a stream of cool water flowing through pipes in the top of the calorimeter. Rubner has estimated that a man loses about 44 per cent. of his heat through radiation and 31 per cent. through convection. Conduction plays a minor role. It is difficult to separate these channels of heat loss.

According to Newton's law of cooling the heat loss by radiation and convection by one body to another surrounding it is proportional to the temperature difference between the two. This is quite accurate for small temperature differences and we need not concern ourselves with the more complicated formulas when we are dealing with human subjects. Our experiments were performed on two normal men who lay naked in the calorimeter at a temperature of 25° C. The rectal temperature was measured by means of an electrical resistance thermometer and the skin temperatures were read in 17 spots using a resistance thermometer devised by Mr. G. F. Soderstrom.

In the first experiment the subject "D" had an average skin temperature of about 33° C. at the start. During the first hour he was quiet. He felt cool but did not shiver and he lost about 70 calories that hour by radiation and convection. During the next short interval we measured the surface temperature and found that it had dropped about one degree. He then started the second experimental period and tried to exercise just enough to keep the surface temperature constant. It so happened that he was successful and maintained the average skin temperature almost ex-

actly at 32°. His mild exercise had of course increased his heat production and the heat loss by radiation and conduction rose from 70 to 81 calories per hour. In other words the skin averaged half a degree colder the second hour and yet it eliminated 16 per cent. more heat.

The second experimental subject "W" did not show as much drop in skin temperature and his mild exercise in the second period warmed him so much that the average skin temperatures were almost exactly the same for the two hours. In the first period he lost about 60 calories by radiation and convection and in the second period with the same temperature he lost about 78 calories.

These two experiments show that under special conditions heat loss is not proportional to surface temperature. A review of the large number of calorimeter experiments that have been performed on patients with fever supports this statement. It is true that the calorimeter measures radiation and convection together but there is no reason to assume that convection is independent of surface temperature. In the case of radiation it is quite probable that the skin does not act as a perfect black-body radiator but possesses the power of changing its permeability for radiation. It is quite possible that the true physiological surface lies in the deeper layers of the skin or in the subcutaneous tissue and that the outer layers of the skin resemble a suit of clothes.

THE ACTION OF THE COMMON CATIONS ON THE PROTOPLASMIC VISCOSITY OF AMOEBA

DR. L. V. HEILBRUNN
Associate Professor of Zoology, University of Pennsylvania

Four cations are common to living substance. They are found in most types of living cells, and biologists are agreed that their presence in these cells is of great importance to the vital machinery. These ions are sodium, potassium, calcium, and magnesium. There is a huge literature concerning the effect of the individual ions on various types of living systems. Muscle physiologists, plant physiologists, students of medicine and of agriculture, all have contributed important experimental observations. We know that a given cation may show pronounced antagonistic effects toward another or other cations. It is also known that two of the cations, magnesium and potassium, may have a pronounced anaesthetic action.

For the general physiologist, it is obviously important to know what physico-chemical effect or effects the various cations may have on the protoplasm. In 1923 I was able to show that sodium and potassium ions increased the viscosity of the protoplasm of sea-urchin eggs and of Stentor, whereas calcium and magnesium ions had the opposite effect. Similar results were obtained for plant cells by Cholodny and by Weber and these observations found an easy interpretation on the basis of colloid chemical theory, if one assumed that the protoplasmic micellae were positively charged. However, in 1926, Chambers and Reznikoff, in studying the effect of the common cations on the protoplasm of *Amoeba dubia*, concluded that sodium and potassium made the protoplasm more fluid, i. e. less viscous, and that calcium and magnesium had the opposite effect. These opinions were based partly on evidence gained from micro-dissection, but apparently more on the fact that in sodium and potassium solutions the granules or crystals of the amoeba were observed to fall through the protoplasm.

It is of course possible that the micellae of amoeba protoplasm are charged differently from those of the other types of protoplasm mentioned previously and that sodium and potassium do actually produce a liquefaction in *Amoeba dubia*. In order to test this point, a series of centrifuge tests was planned on specimens of *Amoeba dubia* immersed in solutions of sodium, potassium, magnesium, and calcium chloride. These tests were performed by Miss Kathryn Daugherty. She made a long series of experiments in each case, and her results show conclusively that sodium and potassium solutions increase the protoplasmic viscosity, and that calcium and magnesium decrease it. On the average there is a 41% increase in the sodium chloride solution, a 21% increase in the potassium chloride, and decreases of 35 and 32% in calcium and magnesium chloride solutions respectively. These findings are in accord with the older work on other types of protoplasm, and they likewise favor the view that the protoplasmic micellae of amoeba protoplasm bear a positive charge. During the past winter, Mr. Katsuma Dan has done some cataphoresis experiments with amoeba which also favor this view.

The fall of crystals which Chambers and Reznikoff observed in potassium chloride solutions is due to stoppage of movement rather than to any change in the viscosity of the protoplasm. The crystals of *Amoeba dubia* are large and they fall readily whenever the amoeba stops moving. In sodium chloride solutions at room temperatures, we have never observed any fall of crystals. However, at 30°, amoeboid movement ceases in sodium chloride solutions and the crystals fall.

The discussion so far has concerned *Amoeba dubia*. When this amoeba is centrifuged at slow speeds, practically all of the crystals move through

the cell. On the other hand, when *Amoeba proteus* is centrifuged at slow speeds, only the crystals in the interior of the amoeba move, and those in the outer cortex or plasmagel remain as they were. But the crystals in the plasmagel can also be moved if the amoeba be centrifuged for longer times at considerably greater centrifugal speeds. The length of time required for the crystals of the plasmagel to move into half the cell when the amoeba is subjected to a given centrifugal force is called the "centrifugal value". For reasons which cannot be gone into here, this value is not an exact measure of the viscosity of the plasmagel, but it can at least be stated that higher centrifuge values indicate higher viscosities, and lower centrifuge values lower viscosities.

When *Amoeba proteus* is immersed in dilute solutions of potassium salts the centrifuge value becomes markedly diminished, so that it is only a small fraction of the normal. In these dilute solutions of potassium salts, the amoeba is completely anaesthetized. It seems fair to conclude that the anaesthetic action of the potassium ion is in some way associated with this pronounced liquefying action. The magnesium ion causes an almost complete stoppage of movement of *Amoeba proteus*; it is only by observing the amoeba for minutes at a time that any movement can be detected. In dilute solutions of magnesium chloride the centrifuge value of the plasmagel is reduced to 68% of its normal value. Both magnesium and potassium anaesthetize and both liquefy the plasmagel. These observations are in excellent agreement with current theories of amoeboid movement. They also give support to the theory that anaesthesia is associated with a liquefaction of the protoplasm, a theory which I proposed some years ago.

The sodium ion has but little effect on the centrifuge value of the plasmagel. Its only action is to cause a slight decrease in the value. As might be expected, amoebae immersed in sodium chloride solutions continue to move. The only one of the common cations which causes an increase in the centrifuge value is calcium, and the effect of this ion is pronounced. The work of Pantin and of Pollock has indicated that calcium is the one cation which is essential for amoeboid movement and its specific action in stiffening the plasmagel is particularly interesting in this connection.

Numerous experments have been performed on the effect of combinations of cations on the plasmagel of *Amoeba proteus.*. Indeed every possible combination has been tried. It will not be possible to consider all these experiments, but it should be pointed out that the liquefying action of potassium and magnesium is antagonized by calcium, and that a trace of this element may exert a very powerful effect.

Our experiments have shown certain effects of individual cations on the interior protoplasm of *Amoeba dubia,* and very different effects of the same ions on the outer protoplasm or plasmagel of *Amoeba proteus.* It is not practicable to study the plasmagel of *Amoeba dubia,* nor is it practicable to study the viscosity of the interior protoplasm of *Amoeba proteus.* It seems a fair assumption, however, that the two amoebae are essentially similar in their behavior toward the common cations. It is fortunate that we have the two forms, one of which can be used for a study of the interior, the other for a study of the cortex. Our study of the interior indicates that this protoplasm behaves toward the common cations like a positively charged suspension. The cortex is very different. Calcium tends to solidify or stiffen it, magnesium and especially potassium have the opposite effect. The anaesthetic action of magnesium and potassium ions has always been a great mystery; their behavior fitted in with no one of the theories of anaesthesia. Perhaps our experiments may throw some light on this mystery.

THE MECHANISM OF BACTERIOTROPIN ACTION

Dr. Balduin Lucke
Laboratory of Pathology, University of Pennsylvania

The experiments here reported were made in collaboration with Drs. Mudd, McCutcheon, Strumia, who are equally responsible for the results.

Leucocytes ordinarily take up living bacteria only to a slight degree. When, however, bacteria are treated with specific immune serum they are readily phagocytized. The substance or substances in serum which promote phagocytosis are termed bacteriotropins.

We have studied the relation between phagocytosis and certain properties of the bacterial surface, namely, cohesiveness, electric charge and wettability. The bacteria used were various species of living tubercle bacilli; the phagocytic cells were exudative rabbits' leucocytes; the immune sera were prepared by injecting rabbits with the micro-organisms studied. In the experiments bacteria were treated with serial dilutions of immune sera and rotated in a Robertson agitator with leucocytes; the degree of phagocytosis was determined from the number of leucocytes which had engulfed bacteria in a given time. Meanwhile, the effect of immune sera on cohesiveness of bacteria was studied by the agglutination and resuspension reactions; the effect on surface

charge was calculated from the cataphoretic velocity. The effect on the wetting properties was determined by suspending bacteria in an oil-water interface; before interaction with serum the micro-organisms used readily pass into the oil; after interaction they resist passing into the oil.

The results of this first series of experiments may be summarized as follows: Sera reacting with bacteria have increased phagocytosis, caused agglutination and increased cohesion of bacteria, decreased the bacterial surface charge, and altered the surface from one readily wet by oil to one wet by water. The changes in these surface properties and in phagocytosis are, in general, of corresponding degree. Alternatively stated, sera which have reacted with bacteria so as to cause increased cohesion, decreased surface charge, and change in wettability, have effected a corresponding increase in phagocytosis.

In the next group of experiments we studied the alterations of surface properties of bacteria and of phagocytosis during the course of active immunization. Tests have been conducted periodically with the sera of rabbits under active immunization and with different strains of tubercle bacilli. Again a close correspondence between intensities of surface reactions and of phagocytosis was apparent. From these experiments the conclusion may be drawn that both surface reactions and tropin effects are due to the deposit of a certain substance or substances contained in immune serum on the bacterial surface.

In the next group of experiments immune sera were fractionated into their globulin and albumin fractions. It was found that solutions of the globulin fractions possess essentially the same properties as bacteriotropic sera. The properties of the globulin fractions were now further investigated by studying the iso-electric point of bacteria sensitized with increasing concentrations of serum or of its globulin fractions. It was found that the iso-electric point of the bacteria so treated is shifted progressively toward a zone lying between pH 5.5-5.8. This is somewhat above the iso-electric point of normal serum globulin.

In the next experiments various proteins (egg-albumin, edestin, etc.) were adsorbed on small collodion particles, and the effect of immune sera and their protein fractions on phagocytosis and on surface properties of these particles, was studied. Essentially the same results were obtained as in bacteria.

In the experiments summarized above polymorphonuclear leucocytes were used as the phagocytic cells. In the higher vertebrates there exist two main kinds of mobile phagocytic cells, the leucocyte and the large monocyte (macrophage). The relative tropin effect upon these two kinds of cells was investigated. No essential differences were observed in phagocytic properties toward the bacteria or particles used.

The general conclusion is drawn that the various surface changes and increased phagocytosis effected by immune sera are all consequences of *one* underlying phenomenon, namely, the deposition on the surface of, and the specific chemical combination with, the antigen of an antibody protein contained in the globulin fraction of immune sera. This globulin appears to possess physicochemical differences from the normal serum globulin.

LIVING NERVE SPROUTS

Dr. Carl Caskey Speidel

Professor of Anatomy, University of Virginia Medical School

Although nerve cells and sheath cells have been cultivated *in vitro* by various investigators and the growth of nerve fibers observed, the formation of the myelin sheath has never been obtained in artificial media. Preliminary observations on frog tadpoles convinced me that it might be possible to watch the process of myelination by direct observation of the transparent fin of living animals. Accordingly, individual nerve sprouts and sheath cells were kept under daily observation for long periods (a few days to several months), and their activities correlated with the development and growth of the myelin sheath.

After early development of the frog tadpole the nerves of the tail fin are partly of the unmyelinated type and partly of the mixed type, including both myelinated and unmyelinated fibers. A few may be entirely of the myelinated type for a part of their course. In the unmyelinated type, and in the unmyelinated portion of the mixed type, there may be distinguished under favorable conditions "myelin-emergent" fibers and "non-myelin-emergent" fibers.

A myelin-emergent nerve sprout differs from a non-myelin-emergent fiber in its greater bias toward myelin formation. The former in combination with a primitive sheath cell leads to the formation of a new myelin segment, the latter ordinarily does not. An exception to this is the formation of the initial myelin segment on each neurone.

The transfer of a primitive sheath cell to a myelin-emergent fiber may be effected in a variety of ways, such as: (a) from the unmyelinated por-

tion of a mixed nerve to the accompanying myelin-emergent sprout; (b) from a nearby, but separate, unmyelinated nerve, following a temporary anastomosis where the two nerves cross; (c) from one nerve to the unmyelinated portion of an adjacent nerve by way of an anastomosis, followed by transference to the myelin-emergent fiber accompanying the second nerve. In each of these varieties, sheath cell migration may be in a distal or proximal direction, and multiplication by mitosis may take place. Transfer from a cranial nerve branch (dorsal branch of ramus lateralis vagi) to a spinal nerve has also been seen. Myelin segment formation has been watched following each of the migration varieties listed above. The transfer of a primitive sheath cell in the reverse direction, i. e., from a myelin-emergent fiber to a non-myelin-emergent fiber, is quite rare. Transfer from one myelin-emergent sprout to another, however, takes place.

Myelin formation proceeds from proximal to distal, each new unit being added at the end of the myelin line, but occasionally gaps are left between two segments. Such intersegmental lengths of nerve fiber may become myelinated by the process of intercalation of additional myelin segments. A fiber about to be myelinated presents a characteristic thickening and becomes somewhat more prominent optically. The earliest myelin is formed in the vicinity of the sheath cell nucleus. It grows from this center by continuous extension in both directions ("nucleo-fugally"). One adult internodal segment genetically corresponds to the zone influenced by one primitive sheath cell.

Early unmyelinated nerves serve to direct in a general way advancing myelin-emergent nerve sprouts, and to furnish them with primitive sheath cells as a preliminary step to myelination. The acquisition of primitive sheath cells by the sprouts is greatly expedited by their movements in extension, retraction, branching, and the formation of temporary anastomoses with adjacent fibers. The early unmyelinated nerves which act as directives for the developing myelin line may be compared to the preterminal plexuses (of Harrison) which are the forerunners of the final end arborizations.

Young myelin segments grow both in diameter and in length. Complete elimination of side sprouts occasionally occurs as the myelin segment becomes longer. Overproduction of myelin is also frequently to be seen at the region of the node of Ranvier. Long myelin segments may be formed by end-to-end anatomosis of shorter segments accompanied by complete obliteration of the intervening node of Ranvier. This is partly responsible for the wide variation in length of myelin segments. It also accounts for the presence of two sheath cells on a single myelin segment. Occasionally, a portion of one segment fuses with the segment next to it, and a new node then develops. The formation of perpendicular myelin units, either at a node of Ranvier or at a nerve terminus, is essentially like that of the formation of parallel myelin units.

The process of regeneration of a single myelin segment following traumatic degeneration has been observed in detail. Regeneration may occur without preliminary sheath cell multiplication or migration. Sprouts from myelinated fibers grow into newly regenerated regions much less rapidly than do sprouts from unmyelinated fibers.

Primitive sheath cells appear to aid nerve sprouts in surmounting slight obstacles in the way of free growth. Growth and extension of nerve sprouts seem also to be stimulated by sheath cell mitosis near the nerve terminus. Other observations include detailed movements of primitive sheath cells in mitosis, extremes of variability in primitive sheath cell migration, and the shifts in position of mature sheath cells on myelin segments.

Many years ago in tissue cultures Harrison saw nerve fibers grow out from nerve cells. Each active outgrowing fiber was provided with a terminal ameboid growth cone. I have been able to find active growth cones in living tadpoles and, under favorable conditions, to watch them for long periods of time. A number of interesting observations have already been made which bear directly on certain problems of neurogenesis and nerve regeneration.

HISTOLOGIC EFFECT OF LIGATION OF THE VASA OF THE SPLEEN OF THE ALBINO RAT

Dr. J. E. Kindred
Associate Professor of Histology and Embryology, School of Medicine, University of Virginia

The object of this investigation was to determine the fate of small lymphocytes entrapped in the vasa and lymphatics of granulation tissue. Maximow ('07) describes the transformation of small lymphocytes into large lymphocytes and thence into erythroblasts in the invading vasa of the ligated kidney of the rabbit. The erythroblasts subsequently mature into normoblasts which usually do not undergo further change. Jordan ('26) has described changes of small lymphocytes into erythroblasts in certain lymph nodes of the rabbit

and dog. According to Jordan the specific stimuli for the modification of the lymphocytes are slow circulation in the medullary blood vessels, and disjunction of the efferent lymphatics with consequent relatively high concentration of carbon dioxide. This condition parallels those suggested by Latta ('21) for the modifications of lymphocytes into erythroblasts in Peyer's patches of the rabbit. Latta emphasizes as necessary for the changes: closeness of association of the lymphocytes to the blood stream, slowness of the current in the blood vessels, and thinness of the vascular walls. Normal erythrocytopoiesis in the bone marrow is thought by Mieschler ('93) and Dallwig et al. ('15) to be dependent upon a definite concentration of CO_2 in this region. If the CO_2 is increased the production of red blood corpuscles is speeded up.

Histologic conditions following ligation of the kidney (Jordan, Kindred and Paine, '31) of the rat were almost identical with those suggested by these investigators. These conditions did not obtain immediately, but only after the autolytic and heterolytic processes characteristic of ligated organs *in vivo* had occurred. The newly formed vasa were thin-walled, having only an endothelial wall. The lymphocytes were present in the vicinity of the vessels and from what is known of the chemistry of autolysis and heterolysis it is probable that there was a higher concentration of CO_2 in this region than is normal. Nevertheless, the lymphocytes differentiated only into plasma cells (Marschalko type) or grew in size into large cells resembling the hemocytoblasts of bone marrow. These changes were extravascular. No intravascular evidences of erythrocytopoiesis such as Maximow described for ligated kidney of the rabbit were obtained. Since it is conceivable that the products from autolysis and heterolysis of the kidney may have contained some substances which inhibited the action of the erythrocytogenic potentiality of the lymphocyte I undertook the study of ligated spleens.

The normal parenchyma of the spleen of the rat has the histologic structure and cellular content characteristic of the mammalian spleen with the addition of megakaryocytes and foci of erythrocytopoiesis. The cellular elements are supported by a stroma of reticulum fibers. The capsule is a thin fibro-elastic layer in which smooth muscle cells are present in addition to lymphatics and fibroblasts. After twenty-four hours' ligation the only viable (histologic) part of the spleen is the capsule and a narrow subjacent layer of macrophages and small lymphocytes evidently kept alive by their closeness to peritoneal fluid. Occasionally bacteria accumulate in vast numbers in the subcapsular region. These bacteria resemble morphologically the germ of infectious anemia (*Bartonella muris*) in rats. A devastating anemic effect by this species of bacteria follows splenectomy.

After three days of ligation a layer of neutrophilic granulocytes is present on the surface of the capsule and during the next few days these granulocytes penetrate the capsule and spread over the periphery of the central necrotic parenchyma. Exactly similar histologic conditions are present in ligated kidneys after the same lapse of time.

At the end of one week the capsule is much thicker than before and is usually adherent to some neighboring organ such as the kidney, pancreas or stomach. Many fibroblasts are in mitosis and the growing tips of blood and lymphatic capillaries are present. They are entering the capsule at right angles to its surface. The lymphatics are filled with small lymphocytes and the blood capillaries with small lymphocytes, red blood corpuscles and neutrophilic granulocytes. Many monocytes and macrophages are present between the capsule and the neutrophils. The products of heterolysis of the neutrophils are apparently stimulating the fibroblasts and endothelium just as they do in tissue cultures according to Carrel ('22).

The critical time of the experiment is reached during the fifth week after ligation. At this time the capsule is very thick. Fibroblasts, collagenous fibers, blood capillaries and lymphatics are very numerous. Not only are the lymphatics filled with small lymphocytes but lymphocytes of all sizes are present external to the capillaries and lymphatics. In addition to the lymphocytes, there are present many so-called plasma cells of Marschalko and all stages between them and small lymphocytes. From the study of sections of spleens ligated for two to four weeks it is concluded that there is a continuous emigration of small lymphocytes from the lymphatics into the surrounding extravascular area. Here under the environmental conditions present these small lymphocytes are stimulated to change into large lymphocytes and so-called plasma cells. No such changes of small lymphocytes have been observed in the capillaries or in the lymphatics. These observed cytologic changes are identical in time and place with those in ligated kidneys The so-called plasma cells are characterized by a polarity of the nucleus. The chromatin is arranged in radiating blocks. The cytoplasm is relatively great in amount as compared with the nucleus and has a homogenous basophilic tinctorial reaction. No vacuoles are present in these cells. The margin is smooth and very sharp in contour. Immediately on the side of the nucleus toward the greatest amount of cytoplasm there is a small area which is distinctly eosinophilic in reaction. This area passes without sharp demarcation into the surrounding in-

tensely basophilic cytoplasm. Many of these cells show changes which grade into the Russell body cells. The cells of this transitional series are characterized by the essential characteristics of the so-called plasma cells, but contain within the cytoplasm one or more discrete globules which have an intense eosinophilic reaction. When these bodies are few and small they are usually spherical, but as they get larger they assume all sorts of bizarre shapes. When the cells are full of these bodies the nucleus is compressed and distorted, but it still retains its characteristic chromatin pattern. None of these cells has been observed in mitosis. From these facts it is concluded that the Russell body cells are the end results of the degenerative changes in small lymphocytes. The changes described above are only intensified during the next five weeks so that by the end of the tenth week there results an adenofibrous mass enclosing a very small remnant of the originally extensive necrotic parenchyma.

From these facts the conclusion is drawn that the sequence of histologic change in the spleen following ligation of its vasa are the same as in the kidney under similar experimental conditions. In both spleen and kidney the differentiation of the small lymphocytes is limited to the formation, extravascularly, of large lymphocytes, possible abortive hemocytoblasts and plasma cells of the Marschalko type. There is no evidence of change of the small lymphocytes, intravascularly, into erythroblasts.

AQUATIC MAMMALS—A DESCRIPTION OF A SPECIAL CELL TYPE IN THE CEREBELLUM

Dr. William H. F. Addison

Professor of Normal Histology and Embryology, University of Pennsylvania

In a histologic study of the cerebellar cortex in a series of animals, I have noticed in certain aquatic mammals conspicuous large cells. These mammals include the harbor porpoise (*Phocaena communis*), bottle-nosed porpoise (*Tursiops truncatus*), sea lion (*Eumetopias stelleri*), manatee (*Manatus americanus*), common seal (*Phoca vitulina*) and whale (*Balaenoptera sulfurea*). Three Phocaena brains were obtained in Woods Hole through the courtesy of the Marine Biological Laboratory and the United States Fish Commission laboratory.

These cells usually occur singly in the granular layer or in the medullary layer, or in both. Often two or three are seen in a folium. Their shape is varied, but in general they are of two forms: (1) narrow elongated, and (2) stellate multipolar. The former often lie near the boundary between the granular and medullary layers. The latter lie more frequently in the middle of the granular layer. In size they are often larger than the Purkinje cells. Similar large cells were reported by Obersteiner ('13) in the elephant and whale.

The position of these cells is shared by several other types of cells:—Golgi cells, type II; synarmotic cells of Landau ('29) and Kesaunaité ('30); and the Golgi cells with long axones, described by Ramon y Cajal. But none of these cells attain the conspicuous size of the large cells here described.

These aquatic mammals all have modified limbs and specialized caudal and trunk musculature adapted for swimming. The vestibular apparatus is apparently large and well developed. The weight of the cerebellum has a high ratio to the entire brain weight. These animals are thus characterized by great cerebellar development, and in them there is seen a cell type which seems to be an addition to the usual cerebellar mechanism.

SCIENTIFIC BOOK REVIEWS

The Vitamins. H. C. Sherman and S. L. Smith. Second Edition. 1931. Chemical Catalog Company.

The theory of the function of vitamins in nutrition has barely a score of years behind it, but what a rich and fascinating story it makes! One is hardly justified in speaking of the *discovery* of vitamins, which may be traced to the early nineteenth or even the eighteenth century, but the realization of the existence of vitamins as distinct entities and of their paramount significance in the life of the animal organism is a gift of the biochemical science of the past few years only. Fresh as the scientific knowledge of these elusive vitamins is, the havoc wrought by their absence is hoary with tradition. Especially, the mariner of the era before the motor-propelled vessels felt severely the scourge of the vitamin lack. In the days of the picturesque clipper ships and interminably long voyages, it was scurvy, as much as the fury of the ocean, which was the cause of untold suffering and added tragedy to the heavy lot of sea-faring men. On those long voyages fresh food was, of course, out of the question and

the supplies furthermore were, of necessity, of the kind which would neither spoil nor take up too much space. The result was that scurvy flourished, occasionally decimating the ship's crew before it could reach its destination. No wonder that this dreaded disease of the mariner caused much concern; and even as far back as 1720, the value of green vegetables, and especially the juices of citrous fruits, was discovered in preventing the occurrence of scurvy or in curing its victims. Scurvy, however, was not merely the dread of the ancient mariner. Even as recently as the World War, at least one garrison capitulated because the men defending the fortress were laid low by scurvy, and the disease was quite prevalent in prisons, asylums and similar institutions. If one cannot be certain of the original benefactor of humanity who *discovered* vitamins, or rather vitamin rich foods, we are well familiar with those who have been instrumental in establishing the vitamin theory of nutrition. Foremost among them is Prof. H. G. Hopkins who, in 1906, clearly formulated the view that the animal body requires a great variety of substances other than protein, carbohydrate, fats and salts in order to live. It must also be acknowledged that C. Funk, who, in 1911, coined the name for these essential dietary substances, recognized that their absence may be responsible for a variety of diseases. The extent of the growth of the subject of vitamins to which Funk has given such a tremendous impetus can be judged not only by excessive popularity, which it unfortunately acquired, but by the unusual volume of work it had inspired in laboratories all over the world. In the valuable monograph of Sherman and Smith, the second and revised edition of which we gladly welcome, the bibliography alone occupies 175 printed pages, which is half the space occupied by the text of the monograph (350 pages.) The bibliography contains approximately 3500 titles and, assuming that this list is exhaustive of the studies on vitamins which have been published for the last quarter of a century, this represents an output of a new paper perhaps every two or three days over that entire period. Undoubtedly, the quality of the work produced at such a prolific rate did not keep pace with the quantity; nevertheless, it signifies both an intense interest in as well as a deep importance of the subject of vitamins. Sherman and Smith trace the growth of the subject in all its details and ramifications. From an original number of three, our knowledge has expanded within a very few years to a definite recognition of six different vitamins. And if one reads the signs correctly, the "vitamin B" which has only recently been split into two separate entities may, in the near future, undergo still further fractionation. In the case of a subject as young and interesting and vigorously growing as that of the vitamins, a monograph, no matter how comprehensive, soon becomes out of date, and one can only be glad to see the second edition of the splendid book by Sherman and Smith in which the authors have conscientiously revised the text to conform with the latest development of this branch of biochemistry. No student of nutrition, nay, one is tempted to say no student of biology, can be without the aid of this valuable monograph. —S. Morgulis.

A Synopsis of the United States Pharmacopoeia and National Formulary Preparations. H. J. Fuller. P. Blakiston's Son & Co., Inc. Philadelphia.

This little volume is one of unusual interest and value to all students and practitioners of medicine. In his preface, the author states: "It is not intended to take the place of the Pharmacopoeia, National Formulary, or any of the well-known recognized works on pharmacy, but is rather intended to precede or supplement these works, as well as the instruction given by the teacher of pharmacy."

As a matter of fact, this book gives to the busy practitioner or medical student the salient facts regarding the sources, preparations and dosage of all the best known drugs. Its style is clear and its tables and index are unusually complete and practical.

It is invaluable for ready and reliable reference, and should be on the desk of every up-to-date practitioner. —W. G. Schauffler, *M. D.*

Genetics and Eugenics. A Text-Book for Students of Biology and a Reference Book for Animal and Plant Breeders. W. E. Castle. 4th edition. plus 474 pp. 14 figs. 21 plates. 36 tables. Harvard University Press. 1930.

This fourth edition of Castle's presentation of the problems and results of genetics is the latest revised form of his book, first published in 1916. There are four parts: (1) The biological basis of genetics, which gives the data fundamental to the discussion that follows; (2) The historical development, showing the order in which ideas have developed from the earliest recognition of the problem of genetics; (3) The essential facts and a presentation of selected and illustrative results so far obtained on both plants and animals; and (4) Eugenics—the relation of these results to the question of genetics in man and race betterment.

Chapters on biometry and on calculating of Mendelian expectations are introduced, the inheritance of acquired characters and the hypothesis of multiple factors considered, and a bibliography of sixty pages is added. The book accomplishes its purpose. —H. H. Donaldson.

Hand-book of Anatomy. J. K. Young. Revised by G. W. Miller. 7th revised edition. 1930. F. A. Davis Company.

This volume presents human anatomy in synoptic form suitable for ready reference and review. It contains a number of well-chosen illustrations. Perhaps the most valuable features are the comprehensive diagrams of nerves and arteries, and various tables. Surgical anatomy and dental anatomy are treated briefly.

—C. C. SPEIDEL.

Twins: Heredity and Environment. D. M. Hirsch. 159 pp. 1930. Harvard University Press. $2.00.

This author, a psychologist and student of Professor William McDougall, has collected data on 58 pairs of dissimilar twins of the same sex and 38 pairs of similar twins living in the same homes and on 12 pairs of similar twins living in dissimilar environments.

The similar or identical twins were selected (a) on the basis of similarity of appearance, voice, gait, expression, etc.; and (b) on the basis of similar school work and general intelligence as judged by the teachers of the twins. The dissimilar twins were selected on a similar two-fold basis.

The author concludes that heredity is about five times as important as environment in contributing to the intelligence of the individual; about four times as important in contributing to head length and height; about twice as important in contributing to weight; and probably from two to four times as important in contributing to impulsive and emotional processes.

To the reviewer Dr. Hirsch's essay seems not to be a very profound or convincing discussion. The most valuable portions of the little book are perhaps quotations from Newman, Muller, and others. —WILLIAM L. DOLLEY, JR.

Outlines of Zoology. J. Arthur Thomson, 8th edition. 28 + 972 pp. 528 figs. Oxford University Press. 1929.

This admirable survey of the animal kingdom from Amoeba to man is remarkable for the wealth of information systematically arranged in a volume of handy size. It contains essentially the information that the beginning zoologist should have, and the skillful use of three points of type gives a sense of perspective that is important, especially in a work of this kind. In the present edition the author has had the help of his son, Dr. D. L. Thomson, in adding more physiological material, and of Mr. R. M. Neill on the structure and development of the mud-fishes. The first six chapters deal in a general way with physiology, morphology, palaeontology, the doctrine of descent, etc. Then follows an account of each of the principal phyla, including general characters, followed by descriptions of typical forms of special interest, then classification, structure, life-history, ecology, and other topics, such as parasitism and relation to disease. The illustrations are clear and significant, and for the most part are original. The final chapters deal with geographical distribution and the factors in organic evolution; then follow test questions, an excellent list of books of reference, and an index.

—R. P. BIGELOW.

Protozoan Parasitism of the Alimentary Tract: Pathology, Diagnosis and Treatment. By Kenneth M. Lynch, pp. xvii + 256. $3.75. 1930. The Macmillan Company.

Doctor Lynch has written a handy book for medical students, practitioners, and others connected with medicine in special ways that make them responsible parties in the diagnosis, treatment, and prevention of protozoan infections. The author's aim to write an eminently practical treatise has led him to omit, insofar as possible, all technical details and controversial questions that might serve to confuse the medical man who has had little or no training in Protozoology. Possibly he has gone a bit too far in this regard, especially in the introductory chapters. However, ample references to the standard treatises as well as to special papers are given, and to some of these the reader undoubtedly will wish to refer when he has finished Doctor Lynch's outline. The book should prove, for the audience to which it is addressed, not only thoroughly useful but also thought-provoking. —L. L. WOODRUFF.

Elements of Water Bacteriology. By S. C. Prescott and C. E. A. Winslow. Fifth edition. 1931. pp. viii + 219. $2.50 John Wiley and Sons, Inc.

For more than a quarter of a century Prescott and Winslow's "Elements of Water Bacteriology" has been a standard text in the field of sanitary water analysis, and the present revised fifth edition insures for the work further years of usefullness. The authors conservatively retain the details of the older methods of water examination, but also introduce a precise account of the newer procedures. However, it is their hope that a somewhat radical evaluation and simplification of the laboratory processes involved may be found possible in the near future. —L. L. WOODRUFF.

The Soil and the Microbe. By Professors Selman A. Waksman and Robert L. Starkey, pp xi + 260. $3 50. 1931. John Wiley and Sons, Inc.

When one recalls that our knowledge of the rôle of microörganisms in soil processes and plant growth has developed chiefly in the past half century, it is remarkable how large a body of information has already been accumulated. And much of the most significant of this Dr. Waksman

and Dr. Starkey marshall briefly in an interesting and instructive manner in "The Soil and the Microscope", so that the reader obtains a vivid picture not only of soil organisms and their multitudinous physiological reactions, but also of the relation of these processes to the origin and development of soils, to the cycle of the elements in nature, and to plant nutrition. The present volume affords an excellent introduction to the somewhat encyclopaedic "Principles of Soil Microbiography" by the senior author, a world authority in the field. —L. L. Woodruff.

Textbook of General Biology. Review of *Textbook of General Biology.* Waldo Shumway, viii + 361 pp. $3.00, John Wiley & Sons.

Professor Shumway has written a very interesting and attractive textbook which ought to appeal strongly to the beginning student. As he says in the preface the "book has been written because of a feeling that there is a place for a fresh survey of modern biology especially designed for those who do not plan to specialize in botany or zoology. Biology, as the term is used in this book, refers to those phenomena of life which are common to both plants and animals. No attempt is made to cover the field of Botany and zoology even in outline form, but rather to select from the wealth of illustrative material offered by each, such facts and theories as have a general significance."

The book begins with an account of the structure and activities of the frog. This is followed immediately by a similar account of the wheat plant. The next chapters may be said to deal largely with the principles of biology. Three chapters on the cell discuss its metabolism, behavior and reproduction. Then follow chapters on "Heredity and the Gene," "Ecology and the Community," "The Evolution of Species." The plant and animal kingdom are then taken up systematically. The book concludes with a chapter on "Applied Biology." Throughout the text the physiological point of view is emphasized, explanations are given of structures, and processes are viewed from a physical-chemical point of view. The book is printed in clear type, excellently illustrated, and generally presents an inviting appearance—no small factor in an elementary text. A glossary includes "all technical terms used in the text."

The author states that it is his "aim to write for these to whom laboratory facilities are not available. Accordingly, illustrations have been used freely to take the place of demonstrative material. These art carefully labelled, and the use of abbreviations has been avoided." It ought to be possible, nevertheless, to use the book in courses where laboratory facilities are available and laboratory work required. —J. W. Mavor.

REPORT OF COMMITTEES APPOINTED TO STUDY THE MATTER OF NOMINATIONS OF OFFICERS AND TRUSTEES

To the Corporation and the Trustees of the Marine Biological Laboratory:

Your committees appointed to study the matter of Nominations of Officers and Trustees submit the following report and recommendations for action by Trustees and Corporations:

(1.) After considering various methods by which those engaged in instruction might be represented upon the Board of Trustees, it is believed that the following action by the Corporation will be the best means of insuring such representation: "The Corporation affirms its position that instruction is a fundamental part of the work at the Laboratory and hence this work should be adequately represented upon the Board of Trustees."

(2.) "That the Committee of the Corporation for nomination of Trustees consist of five members, of whom not less than two shall be non-Trustee members of the Corporation, and not less than two shall be Trustee-members of the Corporation."

(3.) "That on or about July first of each year, the Clerk shall send a circular letter to each member of the Corporation giving the names of the Nominating Committee and stating that this committee desires suggestions regarding nominations."

(4.) "That the Nominating Committee shall post the list of nominations at least one week in advance of the annual meeting of the Corporation."

(5.) "That no trustee shall be eligible for re-election until one year after the expiration of the term for which he was elected."

(6.) The following changes in the By-laws should be adopted to make the foregoing recommendations effective.

Insert in Section I of the By-laws, as printed on page 3 of the Report of the Laboratory for 1930, after the sentence ending "eight Trustees to serve four years," a sentence as follows:

"No trustee shall be eligible for re-election until one year after the expiration of the term for which he was elected."

Insert in Section I of the By-laws, as printed on page 4 of the Report of the Laboratory for 1930, after the sentence ending "as Trustee Emeritus for life", a sentence as follows:

"Any individual, who has served as a Trustee and who has reached the age of seventy, may likewise be elected a Trustee Emeritus."

The entire Section I, as amended, will then read:

"The annual meeting of the members shall be held on the second Tuesday in August, at the Laboratory, in Woods Hole, Mass., at 12 o'clock noon, in each year, and at such meeting the members shall choose by ballot a Treasurer and a Clerk to serve one year, and eight Trustees to serve four years. No trustee shall be eligible for re-election until one year after the expiration of the term for which he was elected. There shall be thirty-two Trustees thus chosen divided into four classes, each to serve four years, and in addition there shall be two groups of Trustees as follows: (a) Trustees ex officio, who shall be the President of the Corporation, the Director of the Laboratory, the Associate Director, the Treasurer and the Clerk; (b) Trustees Emeritus, who shall be elected from the Trustees by the Corporation. Any regular Trustee who has attained the age of seventy years shall continue to serve as Trustee until the next annual meeting of the Corporation, whereupon his office as regular Trustee shall become vacant and be filled by election by the Corporation and he shall become eligible for election as Trustee Emeritus for life. Any individual, who has served as a Trustee and who has reached the age of seventy, may likewise be elected a Trustee Emeritus. The Trustees ex officio and Emeritus shall each have the same right to vote as the regular Trustees.

"The Trustees and officers shall hold tneir respective offices until their successors are chosen and have qualified in their stead."

Although this matter is not strictly within the province of the committees' report, it is thought desirable to call the attention of members of the Corporation to the fact that all should avail themselves of the opportunity, which has always existed but which heretofore has been little used, of bringing to the attention of the Executive Committee at any time matters which they consider of importance to the Laboratory.

Signed W. C. Curtis, *Chairman.*

Committee of the Trustees:
Ivey Lewis, W. C. Curtis.

Committee of the Corporation:
Ivey Lewis, H. H. Plough, H. B. Goodrich, W. C. Curtis.

ANNOUNCEMENT FOR THE COURSE IN PHYSIOLOGY

Dr. Laurence Irving
Associate Professor of Physiology, University of Toronto

The course in physiology has been directed by Dr. Amberson for two years. During that period he has assembled a staff whose members are quite in agreement as to the general plan of operation. They look forward to a continuation of the work together, but they realize that it may not always be possible that one man can spare the time for detailed plans and executive work for a number of years. At the present time Dr. Amberson has asked to be relieved from direction of the course for next year in order to continue research work in Germany.

Since the members of the teaching staff wish to work together on the course in the future, they have proposed that the direction might appropriately rotate among them, allowing each member to take a turn for a year. In this way the problem of organization and planning will be fresh each year to the appointed chief and will allow for the introduction of such new methods as he may devise for development of the common purpose.

An arrangement of this sort assumes in the staff membership an expectation of continuity. For next summer the five present members will return. Dr. W. R. Amberson, Dr. Philip Bard, Dr. R. W. Gerard, Dr. Laurence Irving and Dr. Margaret Sumwalt, with Dr. Irving as director of the course.

It is too early to indicate the detailed program for 1932, but the general plan will resemble that used this summer. The following subjects will be handled during the first four weeks of laboratory work. (1) Electrical phenomena in living and non-living systems (Dr. Amberson). (2) The central nervous system of invertebrates and fishes (Dr. Bard). (3) Tissue and cell respiration (Dr. Gerard). (4) The acid-base equilibrium in sea-water and tissues (Dr. Irving). (5) Permeability studies (Dr. Sumwalt). The subsequent period allows for two weeks further work in any of the subjects which have become especially interesting to the student. If any student develops a particular interest and aptitude in the work and wishes to continue beyond the six weeks formal allotment of time, he may go on with any further investigation which is compatible with the facilities available. The material and equipment is quite adequate for qualified and interested students to start with serious research, and the members of the staff are glad to advise and give assistance.

The first lectures will, as before, be given by the staff in physiology to cover the subjects of the laboratory offerings. After these lectures special lecturers will be invited to present important physiological subjects into which their research has given them special insight.

In making this announcement of the future program it is important to mention our indebtedness to the lecturers who have given their time and interest. We feel that it is an unusual privilege to hear each physiological subject presented with the vitality and penetration that characterize men dealing with their favorite subject. We have also to acknowledge the constant support and good advice of the director of the laboratory. It seems that these acknowledgements properly belong in the announcement because we regard the previous experience as a promise for the future.

The Collecting Net

A weekly publication devoted to the scientific work at Woods Hole.

WOODS HOLE, MASS.

Ware Cattell .... Editor

Assistant Editors

Margaret S. Griffin Mary Eleanor Brown
Annaleida S. Cattell

INDEX TO CONTENTS
(Continued)

BIOLOGICAL ABSTRACTS

Printed matter concerning *Biological Abstracts* has been distributed to the workers at Woods Hole during the past two weeks and is still available. This includes the comprehensive report of the conference held in Washington, March 7, 1931, a review by Professor Frank R. Lillie, and other literature. The Union of American Biological Societies, which is principal sponsor for the *Abstracts*, is directing a program designed to inform the biologists of America and other countries regarding them. More subscriptions are of prime importance at the present time in order that abstracts already accumulated may be printed more promptly, and in order that the interest of biologists may be evident to those who must be asked to provide the subsidy necessary for editorial work. Under the present scheme, the subsidy pays editorial costs, the subscriptions pay for printing, and the Union of American Biological Societies pays for current advertising and similar overhead. At a cost of $9.00 a year to the individual and $15.00 to the institution, no one need be without access to this comprehensive key to biological literature. While older investigators may find most of the literature of their special fields coming to them as reprints, there remain many papers in correlated fields, and other subject matter that must be currently examined. Younger investigators have no such advantage. For them the literature of even a special field must seem overwhelming. It was to meet these situations and to provide an instrument for biological science comparable with *Chemical Abstracts* that this great co-operative undertaking was initiated. Only a little more support is needed to realize the completeness and promptness that are the goal in such an enterprise. If that which is almost within our grasp can be attained, American biologists will have created an "institution" that will be second only to the Marine Biological Laboratory as an aid to research. —*W. C. C.*

TO THE TRUSTEES OF NONAMESSET AND NAUSHON

Tho' in our ranks the lyric muse is scarce,
We must confess, it
Seems that someone ought to pen an ode
To Nonamesset.
Gay exiles once again to native heath
In joy returning
With whoops of gastronomic glee we start
Old beach fires burning!

* * * *

No sand than thine in sandwiches
Nor smoke in eye, is sweeter,
No sheep so blithe, no ticks so tame,
No shoreline ever neater.
From Barnstable to nor'ard, way
Down east to Poponesset
We've vainly sought a substitute
For ancient Nonamesset.
Steaks did not taste as steaks were wont
So sad was our condition
For in Elizabethan ground we'd
Founded our tradition.
So thanks for lifted bans and
Prohibitions well rescinded!
We'll watch our fires well and keep
The brushwood to the wind'ard.

(Signed) *The Society of Serious Steak Eaters.*

DIRECTORY CORRECTION

Whedon, A. D. prof. zool. North Dakota State. OM 39. Br 201.

CURRENTS IN THE HOLE

Date	A. M.	P. M.
Aug. 22	——	12:10
Aug. 23	1:05	1:16
Aug. 24	2:05	2:09
Aug. 25	3:01	3:07
Aug. 26	3:45	3:53
Aug. 27	4:24	4:32
Aug. 28	5:08	5:19
Aug. 29	5:41	5:56
Aug. 30	6:20	6:37
Aug. 31	6:55	7:14

ITEMS OF INTEREST

SCRIPPS INSTITUTION OF OCEANOGRAPHY

Recently Vice President Monroe E. Deutsch of the University of California at Berkeley visited the Institution. He was accompanied by Mrs. Deutsch, Mrs. Koshland of San Francisco and Assistant Dean of Undergraduates L. O'Brien of the University of California at Berkeley.

Last week Prof. W. E. Allen made a trip to Los Angeles on Institution business.

Last week Prof. G. E. F. Sherwood of the Department of English in the University of California at Los Angeles arrived with his family to spend a month at the Institution.

Dr. E. E. Thomas of the Citrus Experiment Station and his family at Riverside have arrived for a two weeks stay at the Institution.

Last week Dr. Merle Smith, Pastor of the First M. E. Church of Pasadena, arrived with his family to spend a month at the Institution.

Prof. Daniel Freeman of Albany College, Albany, Oregon, visited the Institution last week. He is a special student of flat worms and he collected a number of specimens in this locality.

Mr. and Mrs. N. Turner of Mexico, Missouri, parents of Mrs. Shoup, have been visiting Prof. and Mrs. C. S. Shoup for a few days.

A number of summer residents left the Institution at the end of last week, including Dr. D. M. Greenberg and family of the Disivion of Biochemistry and Dr. and Mrs. H. F. Blum of the Division of Physiology of the University of California at Berkeley, and Dr. R. S. Stone and family of the University of California Hospital in San Francisco.

The public lecture in the Institution was given on August 10, by Dr. W. T. Swingle of the U. S. Experimental Date Farm in Idaho, Calif. This lecture dealt with problems and conditions of date culture.

At 4 p. m. on Friday, August 7, Dr. A. H. Gee gave a semi-public lecture on "Lime Deposition at the Florida Keys".

On August 14, Director T. Wayland Vaughan gave a lecture entitled "Notes on Recent and Current Oceanographic Activities".

The position of Dr. G. W. Martin who contributed the article on the Iowa Lakeside Laboratory was incorrectly recorded in the July 25 number of The Collecting Net. Dr. Martin is professor of botany at the State University of Iowa.

MT. DESERT ISLAND BIOLOGICAL LABORATORY

Dr. James Murphy and Dr. E. M. East conducted the seminar on August 5th at the Jackson Memorial Laboratory.

Dr. Warren H. Lewis delivered the fourth lecture in the M. D. I. B. L. Popular Lecture Course on Thursday afternoon, August 6th. His subject was "Cancer Problems" and was illustrated by motion pictures.

On August 7th the members of the Laboratory were entertained at the Marine Biological Laboratory at Lamoine, Me. An exhibition of specimens was given by the students. The visitors were invited to inspect the buildings and grounds. Tea was served at the dormitory.

Dr. and Mrs. W. H. Lewis entertained the Laboratory at a picnic on August 8th.

The Monday evening seminar on August 10th was in charge of Dr. William Wherry who spoke on "Biological Control of Bubonic Plague" and Professor Ulric Dahlgren whose subject was "Disease Among Invertebrates".

—Louise R. Mast.

The Rev. Dr. A. M. Keefe arrived on August 8. He has just spent several days on a collecting trip in the Pine Barrens of New Jersey with Dr. C. J. Niewlands, C. S. C. of Notre Dame University and former editor of "The Midland Naturalist." They visited several little known spots in the central part of the state and secured a number of rare floral specimens.

Dr. William R. Amberson, professor of physiology, and Director of the course in physiology at the laboratory sailed for Germany last week, where he will carry on at the laboratory of Professor Rudolf Hoeber in Kiel during the coming semester.

The Gilbert and Sullivan opera "Iolanthe," which was scheduled for August 16, will be given on Sunday, August 23. The postponment of this concert without advance notice was caused by the temperamental behavior of the victrola, and was sincerely regretted by the officers of the Club.

On Thursday, August 27, the program will include the following selections of the Wagnerian music: "Prize Song" from Die Meistersinger, "Seigfried's Funeral March" and the "Closing Scene" of the Götterdammerung. The "Symphony in D Minor" of Cesar Franck will conclude the program.

The concert scheduled for Sunday, August 30, will include Russian songs and selections from Russian operas arranged by Dr. Borodin. The complete program will be announced later.

THE WOODS HOLE LOG

THE EIGHTIETH ANNIVERSARY OF MR. LUSCOMBE

Mr. Walter O. L. Luscombe, a resident of Woods Hole for fifty-four years, was host at a celebration marking his eightieth anniversary last Wednesday. His home was flooded with visitors and congratulatory messages from the people of Woods Hole and from his Cape and Boston friends. Mr. Luscombe has been responsible in large measure for the Woods Hole Public Library and the new Post Office building, and has in many other ways acted as sort of a Godfather to the residents of this section of Falmouth.

In 1899 Mr. Luscombe was elected Senator for the State of Massachusetts and during his term of office he was chairman of the Committee on Towns and Railroads. He was an active member of a great many other committees, some of which were: Committee on Constitutional Amendments, Committee on Harbors and Public Lands, and the Ways and Means Committee. He is now president of the Cape Cod Chamber of Commerce, a position which he has held for five years, and he has for awenty-five years been one of the Directors of the Falmouth National Bank.

We learn from *The Falmouth Enterprise* that Mr. Luscombe served as deputy Collector of Customs in the days when Woods Hole was an important port along the Atlantic seaboard. He served in this capacity until 1888 and later engaged in the grocery, grain, coal and real estate business. His business is now confined primarily to real estate and insurance.

Since 1896 Mr. Luscombe has attended almost all of the National Conventions of the Republican Party. He is now director of the National Rivers and Harbors Committee which is a Congressional appointment. Mr. Luscombe's many friends were happy to find him in such good health and so actively engaged in carrying out his varied duties for the National, State and local organizations of which he is a part, and in his own business.

The sum of seven hundred dollars was extracted last week from the merchants of Falmouth by an attractive young woman who was supposed to be collecting it for the West Falmouth Public Library. The library knew nothing of the "campaign" and the enterprising visitor has disappeared. It dces not seem as though it should be so difficult to raise $500.00 for The Collecting Net Scholarship Fund in Falmouth.

The public schools in Falmouth will open on September 8.

The construction of a highway connecting Providence with Buzzards Bay, designed to shorten the driving distance between the Cape towns and points to the West, is under construction. The New Bedford Chamber of Commerce will present a protest against this proposed highway when recommendations are presented to the Board of County Commissioners.

Mrs. C. E. L. Gifford has been elected president of the Woods Hole Community Association which assumes responsibility for the Community Hall. The other officers which were elected at the meeting are: William Chambers, treasurer; Mrs. George M. Gray, secretary. The Board of Trustees is made up of the following individuals: Mrs. Thomas E. Larkin, William Chambers, Mrs. Alfred Norris and Mrs. George M. Gray. The Community Hall is over fifty years old and it was first known as Liberty Hall.

During the summer months building permits to the extent of over $95,000 have been granted by the Town of Falmouth. The corresponding sum of last summer was nearly half, which is an indication that residents and visitors are taking advantage of the exceptional economic conditions.

The Coast Guard patrol boat CG 285 was busy last week aiding boats grounded in the recent thick fogs. The schooner yacht *Alamyth*, owned by W. P. Latham, was hauled off a sandbar two miles northeast of Menemsha Bight last Saturday night. The 92-foot schooner, *Michado*, was towed off the Shovelful Shoals near Monomoy Island. A fishing boat went ashore in Woods Hole Harbor, but it was pulled off undamaged. The patrol boat located the lost schooner, *Warella* the next day. The boat was owned by Judge Poland who was sailing from Boston to Nantucket; he was lost in the fog and they towed it to its destination.

Two local men have been discharged from their work of laying bricks for the new grammar school in Falmouth owing to the fact that they are non-union men. The choice was put up to one of these men of joining the Union or of losing his job. He wanted to become a member of the Union, but was unable to raise the necessary sum of $73.00. The man in question, Samuel Pierce, has not had a permanent position for six months, and he finds it difficult to support his family. It is unfortunate that the New Bedford Bricklayer's Union should have sufficient power to prevent residents of Falmouth from building their own schools.

THE COLLECTING NET

Vol. VI. No. 10. SATURDAY, AUGUST 29, 1931 Annual Subscription, $2.00
Single Copies, 25 Cts.

AN EXPERIMENTAL DOG FARM FOR THE STUDY OF FORM AND TYPE

Dr. C. R. Stockard

Professor of Anatomy, Cornell Medical College

A general survey was attempted enumerating the difficulties and problems of maintaining a large colony of dogs. The experience of any one who has kept one or two dogs actually gives no idea of the difficulties arising when the number is increased to a hundred or more animals. One or two dogs may be allowed to run more or less at large without seriously contaminating the area; while among a great number of dogs there are certain to be infected individuals, and these contaminate the others under any limited confinement. Dogs are commonly infested with intestinal parasites, and when many are brought together in a small region the entire ground becomes infected with the eggs of these parasites and every member of the colony is very soon also infected. On removing these parasites with ordinary treatment, the dog is only temporarily relieved, since it (*Continued on Page 262*)

M. B. L. Calendar

TUESDAY, SEPT. 1, 8:00 P. M.

Dr. Albert Tyler: "Artificial Parthenogenesis in the Eggs of the Pacific Coast Echiuroid, Urechis caupo."

Dr. Paul Galtsoff: "Specificity of Sexual Reactions in the Genus Ostrea."

Dr. K. B. Coldwater: "The Effect of Sulphydryl Compounds upon Regenerative Growth."

Dr. N. A. Cobb: "The Use of Live Nemas in Zoological Courses in Schools and Colleges."

THURSDAY, SEPTEMBER 3

Final Scientific meeting beginning at 9:00 A. M.

FRIDAY, SEPT. 4, 8:00 P. M.

Professor Bradley M. Patten, Western Reserve University. "Micro-Moving Pictures Applied to the Study of the Living Embryo."

THE U. S. FISHERIES BIOLOGICAL STATION AT BEAUFORT

Dr. Herbert F. Prytherch

Director of the Station

As early as 1860 Beaufort was recognized by zoologists as an excellent location for studies of the marine fauna and flora of the South Atlantic region. The natural advantages offered here for the investigation of biological problems led to the establishment of a marine biological station by the U. S. Bureau of Fisheries in 1899. The present laboratory which was built in 1902 is ideally situated on a small island in Beaufort Harbor and separated from the mainland and town by a channel about 150 yards wide. This provides very desirable but not inconvenient isolation and assures quiet and pleasant surroundings for research work.

The investigators enjoy a little community of their own on the island, as accommodations in the sleeping quarters are furnished free in most cases and meals are provided at cost in the attractive mess hall nearby.

Immediately to the north of the station is the

TABLE OF CONTENTS

THE U. S. BUREAU OF FISHERIES STATION AT BEAUFORT

Established by the Federal Government in 1899. It is located on a small island in Beaufort Harbor which is separated from the main land by a channel 150 yards wide.

large estuary, known as Newport River, headed by a sluggish fresh-water stream of fair size Westward lies Bogue Sound; eastward are another large estuary, the North river, and Core Sound; the latter connects with the great Pamlico Sound. Adjacent to the sounds and estuaries are large stretches of marshes, and sand and mud flats. Furthermore, the numerous good roads of the vicinity make it possible to reach easily by private automobile or the station's service car various fresh-water creeks, ditches, drainage canals, swamps, ponds, and small lakes.

It is evident, therefore, that the station is so situated that the ocean with its shore lines, bights and fishing banks, the sounds and estuaries with their streams, the ponds, the marshes, and the sand and mud flats are all within easy reach from the laboratory. This makes it possible to obtain conveniently for study a very large variety of aquatic animals and plants, ranging from those that live in the ocean in strictly salt water, to those occupying the sounds, estuaries, and streams with brackish and fresh water. Here may be had fish, oysters, clams, scallops, crabs, shrimp, terrapins, porpoises, water birds, seaweeds, and a host of living things that have no names other than the ones given them by naturalists.

An idea of the wealth of the local fauna and flora may be formed from the fact that 291 species of fish, 153 species of decapod crustaceans—that is, crabs, crayfish, shrimp, etc.—216 species of mollusks, and 132 forms of marine algae or seaweeds, are found in almost the immediate vicinity of the laboratory. Furthermore, the conditions for the study of the aquatic life in its natural environment are excellent, as industrial development and the concentration of population are not great enough seriously to disturb nature, and the plants and animals, as already indicated, may be studied over a very wide range of natural conditions.

The biological station consists of the main laboratory building, the mess house and kitchen, director's residence, pump house, boathouse, carpenter shop, and a terrapin-rearing house. The latter is a building 60 feet long by 25 feet wide and is designed to house conveniently 30,000 young terrapins. Along the shores are several concrete ponds used in terrapin culture.

The laboratory building is a two-story frame structure 70 feet long and 42 feet wide, with two-story wings, each about 52 feet long and 18 feet wide, surrounded by porches. In each wing are six bedrooms for the accommodation of the scientific staff and the investigators from colleges, universities and other institutions of learning, to whom the facilities of the laboratory are open at all seasons. Each bedroom is provided with both

hot and cold running water and the necessary furniture and bedding. The central portion of the building is devoted to investigation, instruction, and administration. The laboratory occupies the entire second story, removed from the distractions and noises inseparable from those parts of the buildings and grounds open to the general public. Along the north and south walls are alcoves for investigators, separated by half-height partitions designed to interfere as little as possible with the free passage of light and air. Each alcove is provided with a table and shelving, and whatever aquaria, dishes, apparatus, and reagents may be required for the particular work in progress; one or two high windows furnish light and ventilation. At each end of the laboratory are two large tank tables with aquaria, which afford facilities for keeping and observing live plants and animals brought in from local waters. Sinks, a fume chamber, and a photographic dark room are situated along the end walls of the room.


THE MAIN LABORATORY ROOM

The first floor of the laboratory building is occupied in part by a museum which is open to the public. It contains many marine animals and plants representative of Beaufort.

On the first floor, in addition to the museum, are a chemical laboratory, two small research laboratories, the director's office, a store room, and the library, which contains about 2,000 volumes. Although small, the library has been selected with special reference to the needs of the investigators, who also may obtain books from the excellent main library of the Bureau in Washington and from the other unusually fine public libraries of that city.

The chief purpose of this article is to acquaint biologists with the fact that the laboratory at Beaufort is thoroughly modern and up to date as a result of recent extensive improvements and alterations. The buildings have been thoroughly renovated and additional equipment installed. The salt-water and fresh-water supplies have been modernized, the electrical system renewed and hot and cold running water provided for the dormitory rooms, which occupy the wings of the building. Compressed air and artificial gas are now supplied to the laboratories. An equally important improvement has been the installation of a central steam-heating plant, which makes the whole laboratory building comfortable for occupancy throughout the entire year.

The floating equipment of the laboratory has also been brought to a high standard of efficiency. A comfortable, sea-going motor cruiser and a smaller speed boat have been placed in commission, and two other launches attached to the station have been rebuilt. The larger vessel is equipped with a laboratory, hoisting gear, nets, dredges and the usual oceanographic apparatus. About a dozen rowboats are provided for the use of the investigators.

The primary purpose of the Beaufort laboratory is to render service to the fisheries through the knowledge gained by studies in pure and applied science. The ever increasing importance of seafoods as a source of the essential elements in our diet emphasizes the need of research in a variety of fields dealing with the species of commercial importance. There are innumerable problems pertaining to the cytology, physiology, morphology and ecology of these organisms in which biologists may find excellent material for studies of fundamental scientific value. The Bureau is anxious to interest investigators from other institutions in such phases of these problems as pertain to their respective fields, but at the same time offers them entire freedom in the selection of such biological studies as they desire to make. Every year outside workers, desirous of continuing their investigation of some special problem, visit the laboratory. It is hoped that the number who do so may be increased and every courtesy and all available facilities will be given them.

The chief investigations conducted at present by the Bureau of Fisheries at Beaufort deal with the biology and cultivation of the oyster, the development and distribution of the shrimp, and the propagation of the diamond-back terrapin. The research work that is being carried on at the laboratory during the present season by Federal investigators and those from other institutions is as follows:

Dr. H. V. Wilson and Joseph Hyde Pratt, Jr., Cellular Behavior in Hydroids; Dr. Bernard Steinberg, Effect of Bacterial Toxins on Various Marine Forms; Miss Rebecca Ward, Behavior of Amoebacytes in Annelids; Dr. Vera

Koehring, Narcosis of Marine Mollusks; Professor Ezda Deviney, Regeneration in Ascidians; Mr. Paul O. Klingensmith, Chemical Studies of Sea Water; Dr. James S. Gutsell, Development and Distribution of Shrimp; Mr. Blount Rodman, Terrapin Culture: Dr. Bert Cunningham, Effect of Temperature on Development of Terrapin Eggs; Dr. Herbert F. Prytherch, Relation of Copper Content of the Water to Oyster Growth and Reproduction; Chemical Warfare Service, War Department, Value of Certain Wood Preservatives for Submerged Structures.

In conclusion I wish to add to this brief description of the station and its work the comments of an investigator who has carried on research work here since its inauguration. Dr. Henry Van Peters Wilson, veteran zoologist of North Carolina and a regular visitor at the Beaufort station, describes the laboratory as follows:

"The station has at its door the open ocean and fine sea beaches. Within what may be called the harbor, which is large and beautiful, passing east and west into sounds, are sand shoals, mud flats, and salt marshes. The tide brings in an excellent plankton. The whole fauna is varied and abundant, and, what is of the first importance, easily accessible to the individual collector. Moreover, through the work of biologists during the past fifty years it is sufficiently known to be usable for many sorts of investigations. The association of Beaufort with the general growth of American biology, as may be seen from the long list of published investigations carried on here, is interesting and stimulating. The laboratory is unusually comfortable and convenient .... the summer climate is healthy and pleasant and the temperature and purity of the harbor water make collecting a pleasure. Beaufort is now easily reached by rail and hard-surfaced highway."

Applications for accommodations should be addressed to the station or to the U. S. Bureau of Fisheries at Washington, D. C.

THE ALLEGANY SCHOOL OF NATURAL HISTORY

Dr. R. E. Coker

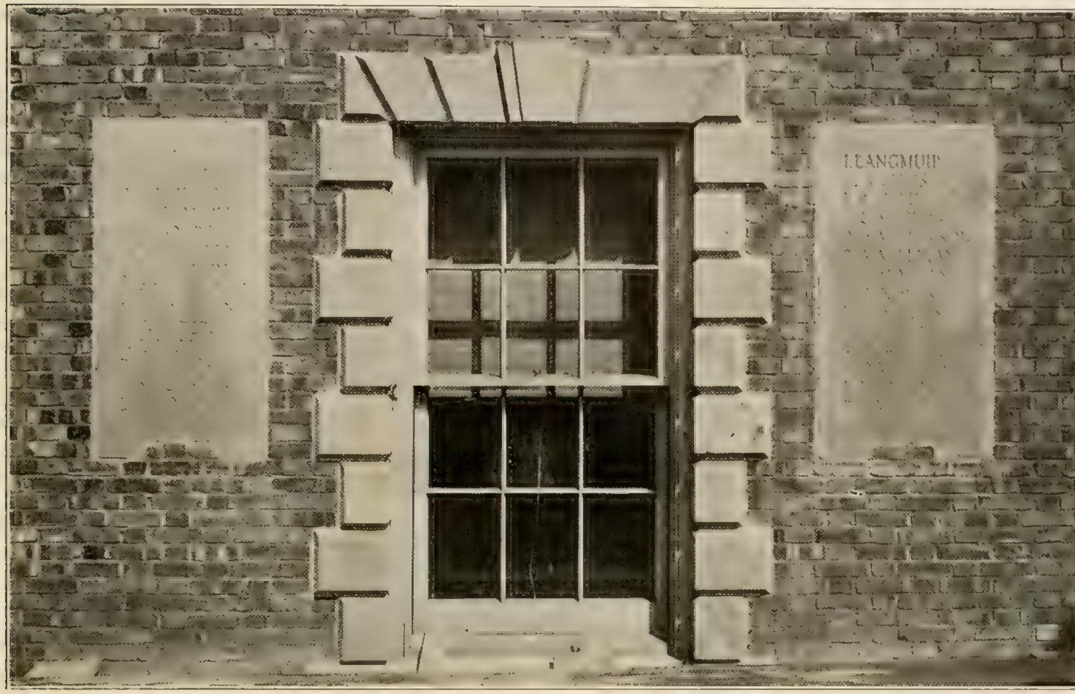
Director of the School

It is a far cry from the salt-washed beaches of Woods Hole, Cold Spring Harbor, and Bar Harbor to the thick forests and swift streams of the Allegheny Mountains; but the field for biological and geological studies is not limited by the wash of the tides. There are inland lakes and streams, mountain sides and meadows that abound in various forms of plant and animal life. There are Crustacea, gastropods, and pelecypods that never knew the sea and a whole class of vertebrate animals marked by the most profound distaste for mineral salts in concentrations proper to an ocean. There is also a class of invertebrate animals more numerous in species than all others combined, whose members scarcely touch the sea.

It is true that Jullanar said to king Shahzeman: "And know, moreover, that all that is on the land in comparison with what is in the sea is a very small matter"; but Jullanar had more imagination than biological information, for, if the textbooks are to be believed, there are many more kinds of animals without the sea than within it. And plants?—but the botanist must say. Obviously there is a place for the lake and desert laboratories, the river and the forest stations, as well as for the marine centers of research and study. The Allegany School of Natural History in the forest appreciates the welcome from its more venerable and distinguished sister at Woods Hole which comes in the form of an invitation to give some account of itself.

The Allegany School, it must be said at the beginning, is not primarily a biological station in the usual sense, although it offers facilities and abundant opportunities for zoological, botanical and geological research. Its primary function is that of a school for field studies in the three general provinces of botany, zoology and geology. Its clientele comprises teachers, college students, both undergraduate and advanced, museum workers , and others. It is yet young, just entering upon its fifth season.

To begin with the birth of the institution: Some six years ago Mr. Chauncey J. Hamlin of Buffalo, President of the Buffalo Society of Natural Sciences and member of the Allegany State Park Commission, conceived the idea of making the State Park perform an educational service greater than could be incidental to the use of the Park as a place for recreation and the passive enjoyment of nature. There was also the interest of Dr. Charles C. Adams, Director of the New York State Museum and a member of the State Council of Parks, who, with Mr. Hamlin and others, had been one of the prime movers for the establishment of a great park in the Allegheny region of New York. The original idea found expression in a joint undertaking for which the Allegany State Park Commission furnished ample grounds, buildings, and fixed equipment, as well as current transportation for classes, the Buffalo Society of Natural Sciences furnished the mov-



THE STONE TABLETS ON THE SCIENCE BUILDING AT THE PENNSYLVANIA COLLEGE FOR WOMEN

A new science building, Buhl Hall, has recently been completed at the Pennsylvania College for Women in Pittsburgh. The idea of placing names of outstanding living American scientists on two stone tablets on the building came to Dr. E. K. Wallace, head of the Chemistry Department. He, assisted by Dr. Anna R. Whiting, head of the Department of Biology, and the students of the Science Seminar group, sent questionnaires asking for suggestions to 906 scientists starred in American Men of Science and representing fields ordinarily taught in a Liberal Arts College. The number chosen in each group was determined by the proportion of starred men in that group. About 600 replies were received. The names have been engraved and it is hoped to hang in the main hall of the building a photograph, autographed if possible, of each of the men on the list. The names inscribed are:

Biologists, Drs. L. H. Bailey, E. G. Conklin, C. B. Davenport, R. G. Harrison, H. S. Jennings, D. S. Jordan, F. R. Lillie, C. E. McClung, T. H. Morgan, H. F. Osborn, G. H. Parker, W. M. Wheeler, and E. B. Wilson.

Physicists, Drs. P. W. Bridgman, A. H. Compton, K. T. Compton, A. A. Michelson, R. A. Millikan, R. W. Wood.

Chemists, W. D. Bancroft, E. C. Franklin, M. Gomberg, I. Langmuir, G. N. Lewis, A. A. Noyes, W. R. Whitney.

Astronomers, W. W. Campbell, G. E. Hale.

---

able equipment, operative management and a member of the teaching staff, and the State Museum furnished the educational direction, several instructors and an important linkage with the well-established research program of the Museum. Shortly afterwards, the interest of the University of Buffalo being incited, the School was affiliated with the University. We should not fail, too, to mention the State Library which, although not ostensibly one of the cooperating agencies, yet, somewhat as a silent partner, contributes in an indispensable way to the efficiency of the School through generous loans each summer of the books and papers necessary to its work.

The Allegany School is located on the slopes of a small mountain just above Quaker Run, one of the most beautiful trout streams of the southwestern part of the state. Just at the School a

dam built across the run by the State Park provides an artificial lake several acres in extent, and twenty feet in depth at the dam. Here, in the heart of an extensive forest, in a state reservation comprising nearly ten square miles, there were constructed a number of very substantial cabins with a campus of some thirty acres.

The School buildings proper consist of a large cabin, 48 x 96 feet, providing laboratories for geology, botany and advanced work or research, a library, and an assembly room, another cabin, 22 x 62 feet, housing the office and zoological laboratory, and two additional single-room cabins. Another large cabin includes the kitchen and incidental storage and working space, and a dining room capable of seating eighty or more persons. There are also a shop with a dark room, an ice house, recreation room, deep well and tank, shower cabins, a number of cabins where staff members and help may live, and twenty-five three-room cabins for students, each designed for the use of two students. At the entrance to the grounds and overlooking the lake, there is an open-air museum which the School conveniently maintains both for its own use and for the interest of the general public. Electric lights in all the buildings and on the grounds, and running-water in the laboratories and at points convenient to all cabins, provide some of the conveniences necessary for the most efficient work.

Class work is adapted both to those coming with little preparation in the special fields and to those entering after a good deal of college training and teaching experience. The classes are small, permitting individual attention, and emphasis is placed upon problem work or report topics adapted to the abilities and interest of the students. Each class period (except on Saturdays) lasts a full day of eight hours, so that there is little limit to the length of the field trip (with bus transportation) or to the inter-adjustment by the instructor of field, laboratory and lecture work. In each department the greater part of the study is, of course, done outside of the class, which meets but one day a week in addition to the Saturday conference hour.

The schedule and arrangement of work is perhaps a distinctive feature of this school, and, after an experience of five years, during which the plan has undergone only minor modifications, we are, as a whole, enthusiastic as to its value for student and instructor. Under this plan, which virtually eliminates all necessity for watching the clock and obviates the waste of time involved in repeatedly putting away papers and equipment and in passing from room to room, the maximum of personal contact between student and instructor goes along with a maximum of continuous independent work by the student. Undergraduate study assumes somewhat the aspect of graduate study with most of its best features in the acquisition of method and the development of a capacity to "carry on" after the student leaves the School. The instructor enjoys the advantage of comparative freedom for research and can the more readily concede the occasional hours for supplemental individual conferences when they become desirable.

As indicated in the beginning, the primary function of the institution is that of a school for field studies. No special attempt has been made as yet to attract independent investigators, although the school welcomes those whose interests lead them to this environment. To such it offers comfortable living conditions, and a congenial social and intellectual environment, as well as laboratory tables and equipment for collecting and keeping animals, plants, or geological specimens.

The present staff of the School includes: A. A. Saunders (Yale), of Bridgeport, Conn. Schools, for Ornithology; W. P. Alexander (Cornell and Leipzig), of the Buffalo Museum, for Nature Study; L. E. Hicks (Ohio State University), of Ohio State University, for Botany; Charles Brewer, Jr. (Harvard and Pittsburgh), of the University of Kansas, for Geology; and R. E. Coker (University of North Carolina and Johns Hopkins), of the University of North Carolina, for Zoology.

AN EXPERIMENTAL DOG FARM FOR THE STUDY OF FORM AND TYPE

(Continued from Page 257)

almost immediately becomes reinfected from the contaminated ground. This has made it necessary to pave all of the kennel runs with concrete. It is much the same sanitary proposition which a human community faces in growing from a sparsely settled village condition into a thickly populated town. It is necessary that the streets and pathways be paved and kept clean. The small number of dogs owned by an individual are usually of one selected breed. The person comes to understand the general habits and behavior of this breed and has little trouble in handling his pets, but when one undertakes to keep a great number of pure line breeds and then makes combinations of these, he soon has an enormous number of actually different animals insofar as their food habits, breeding habits, and general behavior go. All these differences must be understood, and many of the more delicate breeds must be carefully and individually provided for. In addition to the internal parasites mentioned above, dogs are also frequently infested with ex-

ternal parasites, such as fleas and lice, as well as the very annoying mange mites. In order to have favorable conditions for reproduction and growth all these plagues must be consistently eliminated. Pups and delicate types of dogs are highly susceptible to these infestations, while adult, vigorous animals in the same run may be entirely free. There is in a way a certain type of resistance or immunity to parasites on the part of the adult dog. All infections and irritations tend to produce more marked nervous symptoms in dogs than in almost any other mammal. Things that irritate a human being to only a mild degree will often produce a state of extreme nervous agitation in a dog or actually cause fits or spasms.

In maintaining a large colony of dogs one of the most important problems is that of proper feeding and the careful adjustment of their complete diet. With our animals kept in wire-fenced enclosures on concrete pavement there is no opportunity to obtain any other foods or stuffs than those that are actually provided by the kennel ration. We were somewhat surprised to find that none of the commercial and sporting kennels had a properly developed diet. All of the patent and commercial dog foods are considerably deficient in many ways, although they frequently claim to contain all necessary vitamins and salts as well as a perfectly balanced nutritive ration. On these accounts we have found it necessary to use as a base a broken up kennel food, to which we add a freshly-made soup of vegetables and meat. Chopped lean meat scalded by the soup is also used, and then cheap available substances containing the separate vitamins are added, as well as bone ash and the other necessary blood salts. Unless this diet is carefully and properly complete, the animals develop various nervous symptoms and fail to grow in the typical fashion. The absence of vitamin B over any length of time very soon brings about so-called "running fits" and other nervous conditions. When this deficiency is adjusted the fits after a few days disappear. Certain other deficiencies in the diet disturb the whelping reactions of the mother and also completely upset her normal behavior towards the pups in regard to nursing as well as properly cleaning and caring for them. Improperly balanced food causes failure in conceptions and frequent abortions in the breeding animals. Several years work was necessary in order to determine and control these difficulties.

The handling of dogs on a large scale is a very delicate performance, and the kennel men and keepers must be carefully selected persons. We have constantly avoided the employment of any experienced or professional kennel men. Such persons invariably know so much that is wrong about the handling of dogs that it is impossible to teach them any logical method. They also strongly believe many absurd superstitions which are handicaps in handling animals for scientific purposes. We have found that ordinary farm boys who have an interest and knack with animals can be trained to make the most useful kennel men, and all of our crew of kennel attendants are such persons. The keepers sleep in living quarters which are built immediately over the kennel houses, so as to be on hand at any time.

The kennel houses have been built in various ways, and in winter they are heated with either steam or hot water. We have found, however, that simple outdoor kennel boxes or small individual dog houses are far better than well built and heated houses. The small short-haired house dogs actually stand the winter very well completely out of doors in these kennel boxes. Under such conditions there is much less trouble with parasitic infections. It is necessary, in maintaining a colony of this size, that the place be adequately supplied with running water, electricity, and a refrigeration plant. These requirements are not always easy to obtain in isolated positions such as a dog farm must necessarily occupy on account of the barking and noise of the animals.

This dog colony is intended as material for a study of the general problem of the relation of modified internal secretions to structural development and bodily and mental behavior. Dogs better than any other mammals almost exactly parallel the various modified and distorted growth conditions which are exhibited by human beings and which are generally interpreted as being due to modifications in their glands of internal secretion. It has seemed to us most desirable to try and analyze the genesis of such conditions. This, of course, is impossible to do in man. Many so-called glandular diseases such as achondroplasia and acromegaly are very probably complex in both their origin and development. They are not simply the result of an unusual function in some one gland, but more likely a number of glands or possibly all of the bodily organs are somewhat modified. Such a condition can only be understood by a study of the inheritance and development of the conditions. In this way one might find whether there is some one initial peculiarity which secondarily brings about modifications in the other secretions and organs involved. It has occurred to us that by properly crossing different types of dogs which showed conditions comparable to the human glandular diseases we might break up certain complexities into their more or less elementary parts. With this in view something more than a dozen different pure line breeds have been crossed in various ways. By taking animals with a given condition and crossing them with others entirely lacking this condition, we have followed out the genetic behavior of several

peculiar structural forms. A number of illustrations of such crosses through the first and second generations were shown during the lecture.

Supplementing these genetic studies careful histological and cytological examinations of all the glands of internal secretion from the pure line parent stocks and the F_1 and F_2 hybrid descendants are invariably made. Through these studies it is hoped to determine whether the peculiar histology of a certain gland is definitely and constantly correlated with a given bodily structure or form in the adult individual. For example, if the short achondroplasic legs of the Basset hound are associated with a given histological peculiarity of the pituitary parathyroid apparatus, on crossing this hound with the normal long-legged German shepherd dog, the F_1 pups having short legs should also show glandular histology comparable to the Basset, and further, the F_2 pups, some of which are short-legged and some long-legged, should have associated with their leg conditions the parental glandular structures. The instincts, reactions and nervous behavior of different parent stocks and hybrids are being studied in association with these bodily and structural differences.

This extensive investigation presumes that probably the most promising prospect in an understanding of mammalian growth is an analysis and regulation of the internal secretions. Such knowledge may actually aid in the control of resistance to infectious disease, as well as regulate physical and mental development and behavior. At the present time, however, we have only the slightest beginnings of this knowledge.

MICROSCOPIC STUDIES OF CELLS AND TISSUES IN THE LIVING MAMMAL

Dr. Eliot R. Clark

Professor of Anatomy, School of Medicine, University of Pennsylvania

In the latter part of the 17th century Leeuwenhoek first studied, with a simple form of microscope, the vessels in the transparent tails of tadpoles. Passing over sporadic studies on this and other transparent regions throughout the 18th century, which reached considerable proportions during the first half of the 19th century, we find, with the rise of modern microscopic anatomy or histology, usually dated from the time of Schwann (1830-1840), a very considerable use of natural transparent regions in living animals for the study of the finer make-up of the tissues. Among the successors to Schwann may be mentioned Kölliker (1846), Remak (1857), and Stricker (1860-70), all of whom, among other objects, made use of the transparent fin expansions of the tadpole's tail for their microscopic investigations. Such studies reached a climax in the period from 1870-1880 when Arnold, Rouget and others made their observations on the blood vessels in the tail of the tadpole, while the pathologists, Cohnheim, Thoma, Metchnikoff and numerous others, were using transparent living objects such as the frog's web, the mesentery, and the tadpole's tail for their classical study of inflammation. Perhaps this first period of the intensive study of cells and tissues in the living animal may be considered to have come to an end with the studies of S. Mayer on the tadpole's tail in 1884.

Following this time, and coincident with the discovery of the anilin dyes, the attention of histologists and pathologists was largely confined to the study of fixed tissues sectioned with the microtome and stained. This was, of course, both natural and desirable, since such methods made possible the acquiring of a world of information in regard to tissues and organs which were inaccessible to direct observation.

It seems to the author that the late Franklin P. Mall may be considered to have bridged the gap at least in this country — between the earlier period of microscopic studies of the living and the modern one. Dr. Mall informed the author that he had begun studies on the blood vessels in the tadpole's tail with a view to making photographic records of the same vessels over long periods of observation, with correlated studies of the circulation. He had temporarily abandoned this study because of lack of a suitable anaesthetic for keeping the tadpoles immobilized. It was in Dr. Mall's laboratory in 1907 that Dr. Harrison developed the "tissue culture" method for studying growing nerves outside the body. It is interesting to note that before growing nerves in plasma, Dr. Harrison first made observations on living nerves in the tadpole's tail. In 1908, the author began his studies, also in Dr. Mall's laboratory, on living blood vessels in the tadpole's tail. By the use of chloretone anaesthesia and a specially designed micro-aquarium for keeping the tadpole in a normal position, it proved feasible to carry out long continued studies of the same cells and tissues for hours, days, weeks, and months in this beautifully transparent region in a living animal. It was at Dr. Mall's suggestion that the author began the study of the growth of lymphatic capillaries, at that time a subject of heated controversy.

Since 1908 the author has carried out a number

of studies on the cells and tissues in the living animal using the method of direct observation on the tadpole's tail. Since 1916 Mrs. Clark has collaborated in many of these studies. Observations have been made on the growth and retraction of blood capillaries and on the transformation of capillaries into larger vessels, linking the morphology with the physical factors of the circulation. Studies were also carried out on the formation of adventitial cells and their relation to contractility of blood vessels. Extensive observations on the manner of growth of lymphatic capillaries were also made. In addition the development, morphological characteristics and behavior of a number of tissues have been studied under both normal and experimental conditions. For example, observations have been made on the behavior of blood and lymphatic vascular endothelium, connective tissue cells, and various types of leucocytes toward minute quantities of injected substances such as paraffin oil, dilute croton oil, vital dyes, carmin and carbon granules, lipoid substances, protein, starch and allied substances, and toward killed bacteria. The development of tissue macrophages, and their morphological characteristics and behavior, have been studied intensively, and the undoubted transformation of monocytes from the blood stream into tissue macrophages observed. The extra and intra-vascular phagocytosis of erythrocytes have been watched. The regeneration of lymphatics and their behavior in edema have been studied, and a number of other observations on the growth of nerves, muscles, and upon various blood cells, chromatophores, and subcutaneous canalicular cells have been made. The general result of these studies on the living transparent tails of amphibian larvae has been a more intimate knowledge of the life history of a group of cells and tissues as seen in the living animal, and a growing body of knowledge supporting the specificity of cells of this group derived from the mesoderm.

Using the same method and the same type of animal, Dr. S. Culver Williams, working under Harrison, has recently carried out studies on the regeneration of nerves, while Dr. Speidel, at the University of Virginia, is engaged in studies on the growth of nerve sheaths in the tadpole's tail.

During this period, also, similar microscopic studies on tissues in living animals were carried out by Stockard on the early development of blood vessels and blood cells in the transparent embryos of Fundulus, and by F. R. Sabin, W. H. and M. R. Lewis, and others upon early stages of the area vasculosa of the chick, removed from the egg to a hanging drop by the method of McWhorter and Whipple. Of course, you are all familiar with the multitude of valuable studies on living cells made by investigators using the tissue culture method and the method of micro-dissection, although in the case of these last two methods such observations were not made on tissues and cells in the living animal.

During all this period, the author had a persistent desire to extend this mode of study to the mammal. It was realized that the results obtained with regard to the growth and behavior of tissues of the lower vertebrates would not necessarily be identical with the growth and behavior of the same cells in mammals, although the divergence could scarcely be expected to be as marked as was suggested by one investigator, who, at the height of the "lymphatic controversy," after admitting that the growth by sprouting of lymphatic vessels had been proven for the tadpole's tail, stated that the problem then was to discover why the tadpole's tail differed, in this regard, from all other regions in all other animals!

That a similar desire has been felt by other workers is evidenced by the use of oblique or vertical illumination for studies such as those on the blood vessels of the nail bed and other semi-opaque objects. The name of Vonwiller of Zurich should be mentioned in connection with improvements in the use of this method. The mesentery and omentum, objects used for much experimental work in the living animal, are adapted to short-time observation only, while the bat's wing is too thick to be satisfactory for high power cytological observations.

Since there was no natural transparent region in the mammal available for such long continued, high power microscopic studies in the living animal, under normal conditions, it seemed desirable to create one.

It may be of interest to record the steps which led up to the development of the method for inserting transparent chambers into rabbits' ears. The idea of using an artificial transparent chamber came from the results obtained by Ziegler and Maximow in inserting artificial chambers under the skin, and leaving them for varying lengths of time. In 1875 Ziegler made studies on the new vessels and tissues which had grown into a space between two coverslips inserted under the skin of mammals, and in 1902 Maximow gave a beautiful description of the new tissues present in celloidin chambers which were inserted and removed at different intervals, and then fixed and stained. Although both of these investigators made their studies on fixed material their results showed conclusively that new tissue including blood vessels, will invade the thin artificial spaces mentioned above. In 1910 somewhat nebulous plans were formulated for placing such chambers in a mammal so that a thin transparent space could be watched continuously in the living animal. About 1912, when Mrs. Clark was making some micro-injections the fine tip of a glass cannula was accidentally broken off, and remained in her

finger. Several days later, when slight irritation was noticed, the spot was examined under the binocular microscope and the small glass tube removed. It was noticed that capillaries had grown into the lumen of the minute piece of glass tubing. Being unable at the time to think of an arrangement by which a laboratory mammal could be kept still for a sufficient length of time to permit the type of observation desired, I toyed with the idea of attempting the installation of such a chamber in the human finger. However, this experiment was not attempted, and it occurred to me that it would be more desirable in every way to try the operation first on the rabbit's ear. This plan was again postponed because of the lack of a satisfactory scheme for holding the ear still during long observation periods. About 1920, while speculating upon the feasibility of such studies, the suggestion was made by my brother, who had had some experience in agricultural matters, that the rabbit's head might be put in a "stock," as is done with cattle. With this practical suggestion the method of inserting transparent chambers in rabbits' ear was ready for development, and the problem was suggested in 1924 to Dr. J. C. Sandison, then a medical student at the University of Georgia.

Sandison carried on a number of experiments, both at the University of Georgia and at the University of Pennsylvania, until finally, in 1928, chambers were obtained with a sufficiently thin space to permit of careful long-time observation with high magnifications. Sandison was able to make a number of observations on blood vessels and blood cells, some of which have been published, and he was also able to obtain new growing bone in a thin portion of such chambers following a transplant of endosteum at the time of the original operation. Dr. Sandison then decided, in spite of efforts to retain him, to carry out his original intention to complete his surgical training, and unfortunately left us.

Since 1928, a number of workers in the department have been carrying on studies on living cells and tissues using different varieties of transparent chambers inserted in rabbits' ears. It was soon discovered that a great deal of work would be necessary before satisfactory chambers, adapted to different types of problems, which would remain in the ear and in which a uniform space could be retained, could be obtained with anything like uniform success. The original chambers were none of them permanent (four and one-half months being the longest time during which Sandison's chambers remained in the ear). They were also very easily infected and susceptible to drying due to the permeability of the thin kodaloid covers, while neither the extent nor the depth of the thin areas of growth could be controlled. A number of workers enthusiastically took hold of the various problems involved, and many modifications were tried out and improvements developed. In 1929, a five year grant from the Rockefeller Foundation for Medical Research was obtained (largely through the interest of the late Dr. Richard M. Pierce), and still more rapid progress was assured.

It would take too long to recount, at this time, all the subsequent steps in the development of the method, all the various modifications which have been tried out and adopted or abandoned. Each worker contributed one or more suggestions, and all successful ones were immediately adopted by the whole group. By the winter of 1930, four successful types of chambers had been developed and tried out in a sufficient number of animals to demonstrate that they satisfactorily met the requirements for different types of research. These four chambers—the "bay" chamber, the "round table" chamber, the "preformed tissue" chamber and the "combination" chamber — have been described (Clark, Kirby-Smith, Rex and Williams '30). Of these four types, the "preformed tissue" chamber and the "round table" chamber (the latter designed for the study of new-growing vessels and tissues) have been standardized as to construction and dimensions and over sixty of each variety have been successfully inserted in rabbits' ears and studied. Eight of the "round table" chambers, which were inserted from twelve to sixteen months ago, are still in the ears and are still good for microscopic observations.

In addition to the types of chambers described, a new chamber, which might be called the "moat" chamber (as you notice, all of these chambers have names) has recently been developed. The first ones of this kind were tried out by Dr. Hou, of Peiping University, working in our laboratory, and the construction has recently been developed and improved by Mr. Richard Abell. This chamber is adapted to the circulation of fluids of known chemical constitution.

Again, a number of workers in the department have been experimenting with different methods of gaining access to "round table" chambers for the purpose of injecting minute quantities of solid and semi-solid foreign substances, for the transplantation of bits of organs and tissues from other parts of the body into vascularized chambers where their cytological characteristics could be studied in the living condition, and also for the micro-dissection of the new cells and tissues present in the observation areas. Dr. Kirby-Smith, Dr. J. Howard Smith, and Mr. W. J. Hitschler have carried out successful experiments of this kind, having on a number of occasions unsealed the access hole in the bottom of the chamber, injected or implanted small quantities of various substances, and resealed it without causing hemorrhage or other visible injury to the tissue.

The latest improvement has been the use of detached protective celluloid collars, which are quite separate from the chamber proper and which serve as effective splints, protecting the thin area of new growth from undue strain, pressure or tension. About twenty chambers with this improvement have been introduced into ears and followed for several months, and we are convinced that the growth of new vessels and other tissues in such chambers is much more uniform and stable.

Studies on the growth of blood vessels have been made in over sixty standard chambers of the "round table" variety. In this group the growing capillaries started to invade the central table area five to nine days after the operation; in over one-half of the chambers they appeared on the seventh day. The new vessels, which were continuous with circulating vessels in the preformed tissue, steadily invaded the central area from the periphery until they met and anastomosed across the center. Vascularization of the table area was complete one to three weeks after the first appearance of the new vessels. The rate of invasion averaged .23 mm. per diem. In the series of daily photographic records shown in the lantern slides, the chamber was inserted on May 27 of this year; new growing capillaries appeared on the central table on June 2 (6 days), and vascularization was complete on June 16 (14 days). The central table area measured 6.5 mm. in diameter and its radius was 3.35 mm. The average rate of advance of the new tissue was .232 mm. per diem. In a series of standard chambers, all having the same dimensions, there were variations in the rate of growth of new blood vessels ranging from .1 to .6 mm. per diem. Various factors which were found to influence the rate of extension were, temperature, slight injuries which caused small hemorrhages and accumulations of macrophages, the position of the central table in relation to the surrounding cartilage of the ear, and individual variations in the circulation of different rabbits.

During the period in which the new vessels and other tissues are invading the central space a wide variety of observations can be made. Among the studies which have been carried out or are still under investigation, I may mention the following: studies on fibrin, on fibroblasts, on erythrocytes and leucocytes (both inside and outside the vessels), on macrophages and giant cells; studies on the new formation of blood capillaries, on the formation of adventitial and smooth muscle cells on the walls of newly formed vessels, and on the relation between the morphology of blood vessels and haemodynamics; studies on the growth of lymphatic vessels and on the growth of nerves. After the table has been completely vascularized a tremendous variety of problems in morphology, physiology, pharmacology, bacteriology, pathology and parasitology can be studied. Only a small beginning has been made in such investigations.

As the chambers remain longer in the ear and the newly formed vessels and other tissues become older, it has been possible to follow the shiftings in the circulation of the area and the associated changes in the pattern of the vascular network, including such phenomena as the rise and fall of veins, the development of large arteries and the formation of companion veins, the formation of arterial anastomoses and of arteriovenous anastomoses, and to study vascular contraction in relation to the regeneration of nerves. We have also been able to study changes in the lymphatic vessels.

Again, the problems which can be studied by the method of transplantation of organs from other more inaccessible parts of the body into vascularized chambers also cover an immense range. Already microscopic studies have been made upon the growth of bone and of epidermis in the chambers, and preliminary experiments upon the transplantation of liver and kidney tissue and of bone marrow have been undertaken.

Although many of the studies opened up to investigation in the living animal by these methods have barely been started, while still more of them have merely been planned, it has been possible to carry out a few which are fairly complete. For example, in addition to general studies on the growth of blood vessels already referred to, careful observations, many of them with the oil-immersion lens, with daily photographic and camera lucida records, have been made upon the growth of blood vessels and lymphatic capillaries, following the same regions for several months. It has been possible to see with great distinctness, in the living mammal, the mode of growth and the cytological characteristics of both of these types of capillaries and to observe with certainty that, in both cases, the new vessels grow by sprouting of endothelium from that already present, in the same manner as that described for the vessels of living amphibian larvae. In addition many interesting differences in the morphology and in the physiological behavior of mammalian vessels as compared with those of amphibians were observed.

(Lantern slides of photographic records, taken with both low and high magnifications, of the living cells and tissues present in the transparent chambers inserted in rabbits' ears were shown; a reel of motion pictures showing the different types of circulation in arteries, veins and capillaries, the back and forth movement of cells inside lymphatic capillaries, and the shapes, positions, and movement of the various types of cells in the

blood stream was also shown.)

In conclusion, I wish to explain that, in giving this report of studies on the rabbit's ear chambers, I am acting as spokesman for a devoted group of collaborators, each of whom has made important contributions to the development of the method, and whose names are: Dr. J. C. Sandison, Mrs. E. R. Clark, Dr. H. T. Kirby-Smith, Dr. R. O. Rex, Dr. R. G. Williams, Dr. E. A. Swenson (responsible for the motion pictures), Mr. W. J. Hitschler, Mr. R. O. Abell, Dr. J. Howard Smith, Mrs. D. W. Wilson, Dr. L. P. Schenck, Mr. and Mrs. B. Varian (who have taken the microphotographs), Miss Legallais (who constructs the chambers and has charge of the operating room), and Mrs. L. Bentz whose devoted work in raising and caring for the rabbits is an invaluable part of the program.

LOCAL AND CORRELATIVE GENE EFFECTS IN MOSAICS OF HABROBRACON

Dr. P. W. Whiting

Associate Professor of Zoology, University of Pittsburgh

Extensive studies of gynandromorphs and other mosaics in Drosophila have been carried out in the past by Morgan, Mrs. Morgan, Bridges, Dobzhansky, etc. The theory of chromosome elimination in early development seems to fit most of these cases. To explain gynandromorphism in Hymenoptera various ideas have been advanced by Morgan, Boveri, and others. These include the theories of polyspermy and different hypotheses in regard to egg binuclearity. In 1927, Goldschmidt postulated egg binuclearity in the silk worm, Bombyx. Cytological evidence was later found indicating fertilization of two nuclei in one egg. Previously I had advanced a somewhat similar theory to explain mosaicism in Habrobracon.

A female heterozygous for a certain trait, e. g. recessive orange eye color, isolated as a virgin, ordinarily produces eggs which develop parthenogenetically into males of the two expected classes. Occasionally there are found males which are mosaics of the two traits carried by the mother. I assume that in such a case we have post-reduction with reference to these allelomorphic factors. The second polar body remains in the egg along with the egg nucleus and each takes part in parthenogenetic cleavage. If one of these nuclei is fertilized, a gynandromorph results, the fusion nucleus giving rise to female parts, the unfertilized to male. Female parts are therefore biparental, male parts maternal.

Morgan and Bridges in the early work on gynandromorphs of Drosophila noted the striking fact that the male and female parts and their sex-linked characters are strictly self-determining, "no matter how large or how small a region may be, it is not interfered with by the aspirations of its neighbors, nor is it overruled by the action of the gonads."

The majority of mosaics that have been obtained in Habrobracon are very clear cut and represent combinations of a great variety of traits. Many of the male mosaics show mutant characters that have been obtained in the course of X-radiation experiments. I would like to take this opportunity to acknowledge support from the Committee on Effects of Radiation on Living Organisms of the National Research Council which has aided materially in the course of this work.

Despite the fact that in regard to most traits the genetically different regions of the mosaics appear quite distinct and self-determining, a number of instances have arisen in which the characters tend to intergrade, in which there is apparently modification of one part by another.

This has long been noted in eye color. Eyes which are genetically mosaic for black (wild type) and the mutant form ivory do not show clear cut difference between the two regions but grade from black through red or orange. Usually the ivory does not appear as such but the lighter area of the eye is suffused with red color resembling the allelomorphic trait, orange. In several cases the mosaicism is shown only by breeding tests; the insect breeds as black and the eyes, although genetically ivory, are entirely orange in appearance.

Other cases of correlative gene effects may be seen in mosaics for stumpy. This factor from an X-ray mutation reduces the tarsi to mere vestiges but in mosaic males from heterozygous mothers the stumpy legs are somatically intermediate, "semi-stumpy".

Another instance is that of fused. This mutation has occurred independently at least three times but in no case from X-raying. The tarsal segments and the antennal segments are fused together, lacking joints entirely. Mosaic males have fused regions "semi-fused", so that segmentation appears to a greater or less extent.

Exceptions to the rule of self-determination have appeared in Drosophila, vermilion eye color (Sturtevant), bar eye (Bonnier), ebony body color (Stern) and recently, in gynandromorphs of *Drosophila simulans,* Dobzhansky has found modifications of form and color in gonads and genital ducts.

GENETIC STUDIES ON SELECTIVE SEGREGATION OF CHROMOSOMES IN SCIARA

DR. HELEN BERENICE SMITH
Research Assistant to Dr. C. W. Metz, Carnegie Institution of Washington

The genus Sciara belongs to the group of so-called fungus gnats. These flies are small and relatively inconspicuous because of their dark color. About a dozen species have been studied in the laboratory of Dr. C. W. Metz, and certain features have proved especially interesting from the standpoint of chromosome behavior.

Before presenting the results of recent genetic studies, I should like to review briefly certain features of the early work which have direct bearing on the subject I wish to discuss this evening. One of the peculiarities first observed is the presence of an apparently monocentric mitosis which occurs as a normal process at the first spermatocyte division in all the species of Sciara studied thus far. Although the mitotic figure is unipolar, there is a precise segregation of chromosomes. Some go regularly toward the pole, while others go in the opposite direction, ultimately coming together at a point opposite the pole, after being deflected in their course by the periphery of the cell. This latter group is cast off in a bud and takes no further part in development.

The two largest chromosomes go regularly toward the pole; these are termed "limited" chromosomes and will be considered presently. The other chromosomes are present in pairs, though not united in synapsis. These segregate in such a way that one member of each pair goes toward the pole and the other away from it, thus accomplishing an accurate segregation. All of the chromosomes, regardless of their direction of movement, have spindle fibers extending toward the visible pole.

A genetic study of *Sciara capraphila* was undertaken with a view to following the behavior of all of the chromosomes of one species. This could be done if enough mutant characters were secured so that each pair of chromosomes could be identified by at least one gene.

The typical chromosome group comprises ten chromosomes, of which two are very large and easily recognized. Formerly these were thought to occur in males only, but more recently they have been found to be present in the germ line of both sexes, although absent from the soma. Since these "limited" chromosomes are not present in the soma, they cannot be identified by means of somatic mutant characters; consequently I shall leave them out of the present account. Earlier work indicates that they contain relatively few genes and that they are not true sex chromosomes. Disregarding this pair, we are left with the problem of determining the mode of segregation of the remaining four pairs.

The first indication of the type of segregation occurring came from a study of the recessive character truncate wings by Dr. Metz. This character was inherited in such a way as to indicate that during the first spermatocyte division the paternal member of that particular chromosome pair was regularly eliminated, while the maternal member went toward the pole and was transmitted. In other words, the male transmitted only the chromosomes derived from his mother. This suggested that as regards the autosomes the difference in behavior of homologous chromosomes in this monocentric figure might be due in some way to influences impressed on the chromosomes by the sex of the parents. The subsequent studies along this line have been designed to test this hypothesis.

A second chromosome pair was identified when two characters were found which showed sex-linked inheritance. This indicated that the sex chromosome complex of the female was XX, and of the male was XY. However, recently the male soma was found to contain only seven chromosomes, suggesting that possibly the male has no Y chromosome but has a somatic constitution of XO and a germ cell constitution of XX. If this is the case, then segregation of the sex chromosome follows the same course as the autosomes. If, on the other hand, the male proves to be XY, then random segregation would have to be assumed for this pair. Since this question has been discussed recently in two papers (Metz *Biol. Centr.;* Metz and Schmuk, *Proc. Nat. Acad. Sci.*) I will not attempt to discuss it here, except to say that at present the question must be left open.

In each of two other species of Sciara, a character was found which was inherited in the same way as truncate wings, suggesting that perhaps this type of segregation was characteristic. The task of demonstrating this, however, was very laborious because of the difficulty in securing satisfactory mutations. This is due in part to the structural characteristics of the fly (which are such as to conceal all except the most obvious changes) and in part to the type of inheritance in this species; recessive characters tend to be concealed because the progenies are essentially unisexual (which makes sib matings rare) and because selective segregation occurs in the male,

which prevents transmission of paternal characteristics.

At the time when the experiments I am reporting were undertaken, two pairs of autosomes had not yet been studied. X-rays were used in an effort to secure more characters; several new mutants arose, all of which were wing peculiarities. In analyzing each new mutation, tests were made to determine the following points: whether the character was dominant or recessive; sex-linked or autosomal; and whether the male transmitted maternal and paternal characteristics equally. Three mutants were studied, viz., curly, delta, and blister. All were dominant, autosomal characters, and without exception the males transmitted only the characters received from their mothers, showing clearly a selective type of segregation.

Since backcrosses of heterozygous males cannot be made as in Drosophila, the tests for linkage were altered accordingly. In testing the recessive character truncate with a dominant such as curly, truncate females were crossed to curly males (sons of curly mothers). Then the heterozygous daughters were mated to truncate males from pure stock, and the progeny were counted.

In testing two dominants together, such as curly and delta, curly females were mated to delta males (sons of delta mothers), and the heterozygous daughters were outcrossed to normal males. The reciprocal crosses were made in both types of tests.

Curly, delta, and blister were each tested with truncate, and in every case, four definite classes of progeny arose in such numbers as to indicate that the characters probably were not linked to truncate. Tests were made of curly and delta with similar results, making it seem probable that curly and delta were not linked. If such is actually the case, then we have located genes in three different pairs of autosomes, which are represented by the three characters truncate, curly, and delta.

Blister was found to segregate independently when tested with curly, but when tested with delta only two types of progeny arose. The offspring were of two classes, either normal and blister, or normal and delta. The two characters have a similar effect on the fly; their difference seems to be one of degree only. Since no progenies arose consisting entirely of mutant flies, it is apparently impossible to get the two characters together in one fly. It may be that blister and delta are in the same chromosome pair.

The possibility remains that truncate, curly, and delta may be linked, but that they show such a high rate of crossing-over as to obscure this fact. Further tests with more characters are needed to settle this question. But at least we know that all four of the characters studied show the same type of inheritance, the same selective segregation in the male.

An additional recessive character (round) recently found has not yet been tested for linkage, but it shows the same type of inheritance as the other autosomal characters. Likewise two other characters in two other species behave in the same manner. This seems particularly significant in view of the fact that if any chromosomes exhibited random segregation they should be more readily detected by means of mutant characters. These facts taken together indicate that all the autosomes segregate in the same selective fashion, thus supporting the hypothesis that the sex of the parent influences the behavior of homologous chromosomes at the monocentric division. It is possible that the same may prove true of the sex chromosomes and of "limited" chromosomes also.

PHOSPHO-CREATIN IN RELATION TO NERVE ACTIVITY

DR. R. W. GERARD
Associate Professor of Physiology, University of Chicago

When an isolated vertebrate nerve is tetanized, it consumes an extra amount of oxygen and liberates extra heat. The actual values agree when calculated for the oxidation of an ordinary food substance, so it is established that all the energy for nerve conduction ultimately derives from oxidations. The extra heat and respiration, however, outlast the actual period of conduction by many minutes, so that some mechanism for relating the delayed energy liberation to the actual conduction is required. Further, for a few thousandths of a second after activity, a nerve is rapidly changing from a non-excitable to a fully functional state, during the refractory period. A schematic equation series was suggested some years ago to correlate these three phases of activity and recovery, as follows:

(1) $CA \rightarrow A + X$ conduction

(2) $C + A + E \rightarrow CA$ refractory period

(3) $X + O_2 \rightarrow CO_2 + E$ delayed recovery

Here an explosive breakdown of CA is associated with conduction. The substance is rebuilt during the refractory period with the aid of energy made available by the oxidation of an intermediate decomposition product of CA during the late recovery stage. It was believed at this time that CA might represent a hexose phosphate, which led to studies on nerve phosphates. Further work demonstrated, however, that carbohydrate does not enter into the active metabolism

of nerve, and the phosphate studies showed the presence of a fraction behaving like phospho-creatin. Miss Tupikow and I, therefore, undertook to study creatin in nerve to obtain the most direct evidence possible as to changes in phospho-creatin.

Nerves were extracted with iced trichloracetic acid, alcohol was added to the extract, and phospho-creatin precipitated as a barium salt, leaving the free creatinin solution. The two fractions were separately determined after conversion to creatinin by the picric acid method. The distribution of creatin in the free and bound fractions was then determined under a variety of conditions. Further, it appeared that a small amount of creatin remained as a residual fraction in the tissue bulk. The residual fraction is probably bound to some higher molecule, since it has proved refractory to extraction by any method short of prolonged acid hydrolysis.

In the fresh nerve, about one-fifth of the total creatin is residual, two-fifths are free, and two-fifths bound. The total amount obtained by direct analysis without fractionation, or as the sum of the fractions, averages about 160 milligrams per cent in the frog's sciatic, though very marked seasonal variations occur. During rest in oxygen, the bound fraction, if anything, slightly increases. Under anaerobic conditions the bound fraction is decreased and free creatin liberated. In twenty-four hours over half the bound creatin disappears, and most of this change occurs within an hour or two. Even in the presence of oxygen, when respiratory inhibitors are present a similar breakdown occurs. Thus, HCN, H_2S and CO all lead to a breakdown of bound creatin similar to that of anoxia, usually reaching a maximum loss in half an hour or less. The breakdown produced by H_2S is irreversible. That due to the others, is easily reversed by removing the substance and replacing oxygen. The CO breakdown may also be reversed by bright light even though 98 per cent CO, 2 per cent oxygen remains present. CO_2, which has been shown to interfere with metabolic reactions in nerve, also leads to a breakdown of bound creatin.

Finally, even in an adequate oxygen supply tetanization of the nerve also leads to a definite breakdown of the bound fraction with restoration during rest in oxygen. The changes in bound creatin during activity or anoxia agree well with the previously determined changes in phosphate when both are calculated as due to changes in phospho-creatin, so that it may be concluded that this substance is, in fact, involved.

Muscle phospho-creatin responds to all the above conditions as does nerve, though more readily. Methylene blue, however, markedly breaks down the phospho-creatin of muscle, while not affecting that of nerve.

The results indicate that all conditions leading to depressed nerve function are associated with breakdown of phospho-creatin; or, in other words, a breakdown of phospho-creatin in nerve is associated with diminished irritability, prolonged refractory period, less intense conducted impulses, etc. It is tempting to suggest that the original equations be retained with a slightly altered significance attributed to the symbols. Thus, if CA be taken to represent phospho-creatin, which breaks down during conduction to free creatin and phosphate with the X indicating some unknown coupling mechanism for setting off reaction (3), if reaction (2) be the re-formation of phospho-creatin during the refractory period with the aid of energy liberated during reaction (3), and if reaction (3) during the late recovery period represent the liberation of energy by oxidation of some food stuff—quite possibly, lipin—the new data are brought into harmony with all the earlier material. Numerous quantitative considerations, however, must be experimentally met before such a scheme becomes more than a working hypothesis.

THE EFFECT OF SULPHYDRYL COMPOUNDS UPON REGENERATIVE GROWTH

Dr. K. B. Coldwater

Instructor in Zoology, University of Missouri

In normal development the glutathione content of the embryos of the chick and rat has been found by a number of investigators to be inversely proportional to the age of the embryo. More recently Hammett has proposed the hypothesis that the —SH group is an "essential stimulus to cell proliferation". If such is the case, the sulphydryl compounds appear to be intimately related to the development of the organism and its constituent parts. Regenerative development should show similar relationships.

Observations were therefore made on the nitroprusside test for the —SH group given by regenerating tissues, and on the glutathione content of normal and regenerating planarians. The effect of glutathione and other sulphydryl compounds upon the rate of regeneration of planarians and the annelid Tubifex was tested.

The nitroprusside reaction which may be interpreted as indicating the presence of protein fixed, insoluble —SH groups was applied to regenerating tissues of Hydra, planarians, Tubifex, and the

regenerating tadpole's tail. The test showed a greater concentration of sulphydryl in regenerating tissues as compared with adjacent non-regenerating tissues. A single series of determination of the glutathione content of normal and regenerating *Planaria maculata* was made by the Tunnicliffe iodine titration method. An increase of the content of reduced glutathione was found during the early period of regeneration. This increase coincides with the period of active cell division. A substantial decrease was noted in the later stages of regeneration. The determinations also showed a progressive increase in the glutathione content of normal planarians during the period of resorption of sexual reproductive organs and inauguration of the period of fission.

The above observations indicated that the —SH group is in some way related to the regenerative processes, and the effect of sulphydryl compounds on the rate of regeneration in *Planaria maculata, Procotyla fluviatilis* and *Tubifex tubifex* was tested. No acceleration of the rate of regeneration of tail pieces was obtained in *Planaria maculata.*. No head formation was observed in either control or test regenerating tail pieces of *Procotyla fluviatilis.*

The rate of regeneration of posterior segments of the annelid *Tubifex tubifex* was found to be accelerated by glutathione, cysteine and thioglycollic acid in appropriate concentrations. This acceleration was largely confined to the first few days of regeneration.

The rate of regeneration of Tubifex is markedly inhibited by four to five weeks' starvation. Treatment of such starved individuals with —SH compounds during regeneration resulted in an increase of about 100 to 500 per cent in the rate of regeneration as compared to corresponding starved controls.

The figures of comparison were averages of counts of the regenerated segments and measurements of the length of the regenerated areas of large numbers of worms.

The capacity for regeneration in Tubifex is inhibited or completely destroyed by X-ray exposures of sufficient intensity. Sulphydryl compounds do not influence this inhibition or destruction of the capacity for regeneration by X-rays.

The acceleration of the rate of regeneration in Tubifex might be interpreted as confirming Hammett's hypothesis. However, there are certain other explanations which may be suggested. Since the regenerants were kept in standing water, —SH compounds may induce an oxidation of toxic excretory products which would possibly inhibit growth. Sulphur compounds are known to be utilized in certain types of detoxications in the organism. With prolonged starvation and the accompanying tissue breakdown there might plausibly be an accumulation of inhibitory substances which are eliminated only after conjugation with sulphur. Sulphydryl compounds are considered important in this type of detoxication.

RECOVERY FROM X-RAY EFFECTS AS OBSERVED IN THE ARBACIA EGG

DR. P. S. HENSHAW

Biophysical Laboratory, Memorial Hospital, New York City

In studying the effects of radiation on living material one is dealing with a causative agent that alters certain kinds of physiological activity. Many effects produced by X-rays or gamma rays can be described qualitatively, as morphological or as functional changes. But in order to compare such things as the effectiveness of different wave lengths or intensities of radiation, it is necessary to establish quantitative relationships between the amount of effecting agent used and the effect observed. Fortunately, it has become possible during the past few years to determine dosages of radiation with a fair degree of accuracy by measuring the ionization that a given beam produces in free air. Obtaining a quantitatively-measurable biological response to radiation is, however, a more difficult matter. Ionizing radiations produce many biological changes, but very few of the responses lend themselves to accurate measurement. Such things as reddening of the human skin, stunting in growth of plantlets and survival in Drosophila and Ascaris eggs, etc., have been used, but because of the indefiniteness of end points, changes in sensitivity, etc., none of these has been found entirely suitable as a biological test object. In search for something better, marine invertebrate eggs were tested.

It was found that around 50,000 Roentgen units were required to prevent the eggs of Arbacia from fertilizing and undergoing cleavage. Because of the high resistance of this material survival was not a good end point to use. Further investigation, however, indicated that the onset of the first cleavage was delayed by exposure of the eggs to X-rays before fertilization, and it was found that with an increase in dosage there was a corresponding increase in the amount of delay. By developing methods of determining the cleavage time accurately a quantitative measure of biological effect was at hand for the instant when the eggs are fertilized.

The time that is usually required for the first cleavage to occur in Arbacia eggs after fertilization at room temperature is around 55 minutes. Experiments showed that 40 to 60 minutes' exposure (25,000 to 31,000 r units) to the unfiltered

radiation from a Coolidge tungsten target air-cooled tube, maintained at 130 kv. and 5 ma., was sufficient to double the cleavage time. Values varied from day to day, so different exposures were always made on the same collection of eggs.

Plotting the values thus obtained from the different experiments against the dose administered gave curves that were similar in shape, but which varied in slope. By following suggestions obtained from the experiments, samples of eggs were fertilized at different periods after irradiation. This led to the very interesting discovery that a process of recovery began as soon as any effect was produced. That is, the X-ray effect was being lost.

By thoroughly developing the data obtained, several interesting facts were disclosed: (1) By plotting logarithmically the cleavage retardation for different doses at different periods after irradiation against the dosage on a natural scale, it was found that the percentage relationship of the degrees of effect was maintained after irradiation irrespective of the recovery. (2) Accordingly, it followed that the rate of recovery was the same for all degrees of effect produced. (3) Plotting a summary curve of recovery on semilogarithmic paper indicated that the rate was governed by the exponential law.

Although the data fit this specific relationship very closely, the latter statement is as yet not entirely justified. Indeed, it would be very unusual to find such a simple law governing the action of radiations in any living process. It is puzzling to think whether the observed recovery process is a purely physical phenomenon involving the stabilization of an equilibrium, or whether it is a process involving vital activity. In biological repair, one usually thinks of wound repair which necessitates the multiplication of cells and a modification of the nature and relationship of the surrounding tissues. Such repair usually requires a period of days or weeks. In this experiment, however, a damage has been produced not in a tissue but a single cell, and in such a way that trauma is not evident. The injury is most likely dispersed throughout the whole system in the form of molecular and atomic injury. It is not possible to say at present whether *biological activity* as distinguished from *non-biological activity* can repair such injury. Speculation is not profitable, so at this point more concrete experimental evidence regarding the nature of the recovery from X-ray effects must be awaited. However, from the evidence already set forth, it seems perfectly plain that any general explanation of the biological effects of X-rays will have to allow also for reversibility in some effects produced.

ARTIFICIAL PARTHENOGENESIS INTHE EGGS OF THE PACIFIC COAST ECHIUROID, URECHIS CAUPO

Dr. Albert Tyler

Instructor in Embryology, California Institute of Technology

The eggs of the echiuroid, Urechis, may be activated by various hypotonic solutions ranging from 80 per cent. sea water to distilled water. Two types of activated eggs appear as a result of the treatment. In one type the initial changes undergone by the egg are indistinguishable from the corresponding changes in normally fertilized eggs. For this type the breakdown of the germinal vesicle, the rounding out of the indentation, the elevation of the membrane, and the extrusion of the polar bodies take place in the same manner and on the same time schedule (allowing for the time of treatment) as for the fertilized egg. However, practically none of the eggs of this type divide.

The other type of egg obtained by artificial treatment undergoes initial changes that are quite different from those induced by the sperm. The eggs of this type remain indented for about fifteen to twenty minutes after the others have given off the second polar body. The only change that occurs up to that time is the dissolution of the germinal vesicle. They then begin to round up and elevate membranes, but they extrude no polar bodies. However, practically all the eggs of this type cleave, and develop into swimming embryos. A small number (less than one per cent.) of the embryos are normal top swimmers indistinguishable from those produced by normally fertilized eggs.

The results of observations on the polarity of fertilized and artificially activated eggs show that the innermost point of the indentation marks the pole of both. Thus the low percentage of normal development of the pathenogenetic eggs cannot be attributed to a disturbance in the polarity of the egg. But the low percentage of normal development can be accounted for by assuming that the action of the sperm insures the development of bilateral symmetry in the embryo, whereas in its absence the establishment of bilateral symmetry is more of a matter of chance. Observations on the relation of the entrance point of the sperm to the first cleavage plane show 71 per cent. of exact coincidence. Since the first cleavage plane bears a definite relation to the plane of bilateral symmetry, it appears that the sperm is instrumental in determining bilateral symmetry. The above assumption would also account for the appearance of radially symmetrical embryos among

the larvae of artificially activated eggs.

The relative percentages in which the two types of artificially activated eggs occur vary in a definite manner with the length of exposure to the dilute sea water. For any dilution of sea water from 45 to 75 per cent. the total activation first increases with the length of exposure until it reaches 100 per cent. and then returns more slowly to zero per cent. The maximum of 100 per cent. activation is obtained more rapidly with the more strongly hypotonic solutions. For example the maximum is obtained in 3½ minutes with 75 per cent. sea water and in one minute with 45 per cent. sea water. The variation of total activation with time of exposure thus gives a skew distribution curve, which is shifted to the left for the more strongly hypotonic solutions. However when the total activation is plotted against the average volume attained at various times of exposure, fairly symmetrical distribution curves are obtained which are roughly identical for the different hypotonic solutions.

When the eggs are exposed to the dilute sea water for a length of time that results in 100 per cent. activation, it is found that all of the eggs are of the first type described above. They all give off both polar bodies, but none of the eggs divide. However to either side of this "optimum exposure" increasing numbers of eggs of the second type are obtained. These eggs produce no polar bodies, but practically all of them divide. This leads to an inverse relation between the total percentage of activation and the percentage of cleavage, such that when a low percentage of activation is obtained practically all of the activated eggs divide, but as the percentage of activation increases fewer of the activated eggs divide, until at 100 per cent activation none of the eggs divide. Similarly to the right of the maximum point as the percentage of activation decreases the percentage of cleavage (of the activated eggs) rises.

Due to this inverse relation between cleavage and total activation it is impossible to find a time of exposure to the hypotonic solution that will result in all of the eggs dividing. However since the ability of the artificially activated egg to divide was found to depend upon the failure to extrude polar bodies it seemed likely that suppression of the polar bodies by means of a second treatment should enable those eggs to divide that ordinarily would not do so. Attempts were therefore made to suppress the polar bodies of the artificially activated eggs that would ordinarily produce them. These eggs are of the first type described above and can be distinguished from the type of egg that extrudes no polar bodies, even before the time of the polar division. Also by using lengths of exposure that give 100 per cent. activation, only eggs of this type are obtained. Various agents, such as ether, low temperature, hypertonic and hypotonic sea water were used for the second treatment, but the hypotonic solution was found to be the most effective in suppressing the polar bodies. It was found that when the polar bodies are suppressed by means of a second treatment, most of the eggs so treated do actually divide. When the second treatment is applied after the appearance of the polar bodies, no cleavage is obtained. The polar bodies could be suppressed in practically all of the eggs by a second treatment with 55 or with 60 per cent. sea water starting about eight minutes before the polar bodies are due to appear and continuing until about five or more minutes after the second polar body appears in the controls. As high as 85 per cent. of cleavage has been obtained after such a second treatment whereas the control eggs show no cleavage at all.

BIOLOGICAL SPECTRUM AND M-RAYS

Dr. Dmitry N. Borodin
Independent Investigator, Yonkers, New York

My work on M-rays (mitogenetic rays), discovered by Gurwitsch, was directed along three main lines: (a) the improvement of technique in detection of M-radiation; (b) the search for the most demonstrative evidence; and (c) the study of the biological and physical properties of M-rays.

So far the emanation of M-rays has been studied from seventy different biological objects, including several bacteria, yeasts, different plant tissues, animal tissues, blood, muscles, nerves, embryonic tissues, chicken embryo yolk, sea urchin eggs, Drosophila larvae and pupae, haemolymph of a crab, etc. Two methods have been used in the past for the detection of M-rays: the onion root method and the yeast budding method. Two similar yeast cultures on agar blocks in a moist chamber comprise the neceessary set up if the yeast budding method is used. One culture serves as a "detector" and is exposed through a quartz plate to some biological object used as a "sender"; the second identical culture serves as a control. The budding cells are counted, and the percentage of budding is estimated separately in the exposed and the unexposed cultures, and the induction percentage, "Ind. %", is estimated by a comparison of the exposed with the unexposed. The yeast budding method is

very sensitive and requires relatively few hours for experimenting and counting. However, both methods are not very demonstrative.

In order to obtain more demonstrative evidence, I applied a "planimetric drop culture method." Drop cultures of yeast were used by me independently (1928) and by Baron (1930). Two hanging drops of maltose medium inoculated with yeast are placed in a miniature moist chamber, with a bottom of crystalline quartz. One drop of each pair is exposed to the biological object through the quartz bottom, the other serving as a control. The relative rate of growth of the yeast colony in the exposed drop serves as the criterion for the determination of the presence of M-rays. The drops were photographed after 12, 24, 36, 48 and 60 hours. The area of each maltose drop (the amount of food available) was then measured with a planimeter. Measurements were made of equally shaded areas of the yeast colony in both drops, experiment and control. The ratio of the size of the yeast colony to that of the mother drop was estimated. The difference between the ratios obtained was combuted with the ratio for the control, to secure a measure of the effect of induction based on the amount of growth in the control. The curves characteristic of the growth of exposed and control yeast colonies were found for two species: *Z. Pombe* and *S. ellipsoideus*. The curves show that the maximum stimulatory effect of M-rays on the growth of yeast occurs at 12-48 hours. This difference decreases after 60 hours. As senders, the yeast, *S. ellipsoideus*, and the bacterium, *Phyt. tumefaciens*, were used. The planimetric drop culture method was first demonstrated at the American Association for the Advancement of Science meeting in Cleveland, Ohio, in December, 1930. At the present time, this is the most demonstrative biological method for the detection of M-rays, but it is not very sensitive.

Agar cultures of three different yeast species were used as detectors in a set of my experiments on biophysical properties of M-rays. The mercury vapor lamp, the aluminum and the aluminum-zinc spark gap were used as sources of monochromatic ultra-violet radiation, or physical senders. The agar cultures of yeast were placed against different spectrum lines. Thirteen mercury lines from 1849 to 2804 A. U., 5 aluminum spark lines from 1930 to 2816 A. U. and 6 aluminum-zinc lines from 1850 to 2801 A. U. all gave a high induction percentage in the yeast growth. Spectrum lines less than 2004 A. U. also gave induction, but the exposure had to be longer. No limit in the shorter wave length region has been found. Spectrum lines from 2857 to 3650 A. U. do not give an induction effect. If the exposure is short from 0.01 second to 0.1 second, but repeated periodically at intervals of from 0.01 second to a few minutes, a given degree of induction effect is obtainable in a shorter gross as well as a shorter net time of exposure. A yeast colony used as a sender also affects another yeast colony used as a detector in a shorter period of time (both net and gross) if the exposure against each other is interrupted by a revolving disc placed between the two yeast colonies, as compared with uninterrupted exposure of similar colonies. Further experiments showed that the living cells respond to the adequate wave lengths combined with the rhythm of the periods of exposure and interruption. The ratio of the time of a single exposure to the time of the following pause in this rhythm I call the "bio-quantum." For each biological object used as a detector there is an optimum ratio called the individual biological quantum, to which it responds by the greatest increase in the tempo of cell division.

An isolated frog heart, muscle in tetanus, or a colony of *B. acidi-lactici*, when used as senders of M-rays through a quartz spectrograph with interruption by a revolving disc with a slit, create definite induction in yeast cultures placed on agar blocks in the path of the emerging spectrum. Such induction between 2000 and 2400 A. U. was obtained first by Frank (1929) from the Sartorius of a frog in tetanus as a sender and confirmed by me the same year, and extended to a wider range —namely, 1857 to 2700 A. U. I observed that M-rays are not monochromatic and create a "biological spectrum" which is not the same for different biological objects used as senders. The biological spectra obtained by me from the three different objects mentioned are not identical. A muscle, Sartorius of a bull frog, in tetanus in a quartz chamber produced induction in the yeast cultures between 1849 and 1942, and 2026 and 2345 A. U. An isolated heart of the same frog produced two wider bands of induction between 1849 and 2150 A. U., and between 2262 and 2400 A. U. *B. acidi-lactici* gave a band from 1942 and 2026 A. U. and from 2262 to 2269, and near 2345 and 2378 A. U. The biological spectrum must be molecular and not atomic. The first indication of a spectral character of radiation from the three biological objects mentioned was obtained by me two years before the similar results obtained and the detailed study made by Kannegiesser and Lydia Gurwitsch (1931) were published. The expression "biological spectrum" for the identification of this phenomenon was applied by me before the other terminology was created by the afore-mentioned investigators. The term "biological spectrum" was introduced at the International Congress of Physiology, held in Cambridge, Massachusetts, in the Fall of 1929. A biological spectrum is an analysis of non-mono-

chromatic M-rays emanating from a definite biological object (sender) by means of a yeast budding method through a quartz spectrograph; the intensity of bands is indicated by the induction percentage of yeast budding.

It seems that M-rays are not emanating constantly from a living cell or tissue but in an interrupted form and appear in some individual quanta, the number and properties of which are to be studied. The biological spectrum in combination with the bio-quantum may add more to the understanding and explanation of life processes of development and functioning, being closely connected with the molecular structure of the smallest units of life. My experiments on the biophysical effect of interrupted radiation and biological spectroscopy and spectrography were carried on at the W. Kerckhoff Laboratories of the California Institute of Technology, Pasadena, where I was during the summer of 1929, through the hospitality of Dr. T. H. Morgan.

* Added to the program of the scientific meeting held at the Auditorium of the Marine Biological Laboratory on August 25. A movie film of yeast cell division was demonstrated illustrating the yeast method of detection of M-radiation.

THE USE OF LIVE NEMAS (Metoncholaimus pristiurus) IN ZOOLOGICAL COURSES IN SCHOOLS AND COLLEGES

Dr. N. A. Cobb

Nematologist Principal, U. S Department of Agriculture

Answering numerous requests for a free- living nema suitable for school and college laboratory class work, attention is called to *Metoncholaimus pristiurus,* a slender five-millimeter nema common in European and North American stagnant marine mud, below low tide—e. g., in the harbors at Woods Hole and Naples—a form suitable for study alive with moderate, and even high, powers of the microscope. It is a well differentiated bisexual nema that can be sent by post or express long distances in a living condition, and there seems no reason why the already established collecting agencies should not supply it alive to any laboratory director in the country at a moderate cost. It withstands journeys of thousands of miles. It has been successfully shipped (both summer and winter) from Woods Hole to a number of laboratories and successfully used in class work. One laboratory director reports a "very interesting and exciting two-hour period — well worth while". This nema may be ordered from the Supply Department of the Marine Biological Laboratory, and no doubt could be supplied from Naples and many other harbors. Laboratory instructors will find readiest guidance to the anatomy, etc., of this and very similar nemas in the *J. Wash. Acad. Sc.,* June 19, 1930.

Experienced nematologists consider free-living marine nemas the best teaching material for entrance to nematology. Metoncholaimus belongs to a large marine group,—abundant along the shores in all oceans, and may perhaps be considered as nearly "a typical species" as one is likely to obtain from such an immense and varied phylum. It is no easier to select a "typical" nema than to select a "typical" vertebrate. If the morphology of the vertebrates be "covered" by the study of, say four forms, fish, frog, bird and mammal, then in order correspondingly to "cover" the morphology of the nemas, we should have to choose, not four types, but perhaps twice as many. Doubtless there are ten times as many species of nemas as of vertebrates, and they occur in a vastly greater range of habitat, with a corresponding range in morphology. With the above very important reservation, *M. pristiurus* may be regarded as more or less typical.

If by chance any of you should ever care to, you can collect this nema with the use of a simple two liter iron waterpipe dredge, weighing three kilos, its drag rope being linked to a single point on its front rim, and long enough to permit a cast of several meters. Casting from the wharf just down the road your first haul is not unlikely to contain hundreds of specimens, and, as this nema is about the largest in its native mud, it is readily assembled for study or shipment by the use of these ordinary sieves, one (3 mm. mesh) that catches the coarse debris and lets the nemas through, and the other (1 mm. mesh) which catches the nemas and a little coarse mud, and lets the silt through.

It is very important to the student that he study living material. For examination alive, *M. pristiurus* may be mounted in a droplet of clear sea water (fresh water being lethal) under a thin coverglass with just sufficient pressure to keep the nema from moving more than a very little. This pressure can be applied by drawing the extra sea water from under the round coverglass with a sliver of absorbent paper until the nema can barely move, and then sealing in at once on a turntable with a modicum of smoking hot wax

(formula, one of beeswax, three of paraffin) best applied from the wick of an ignited 5-millimeter-gauge *taper made of the wax,*—somewhat like a small Christmas tree candle;—but boiling hot wax and a No. 2 water color brush will answer. A *small amount of movement* of the nema during microscopic examination is *very desirable* because the various nemic organs reveal their contours more readily when sliding slightly one on another.

The advantages in using this metoncholaim are: (1) It is of a size suitable to student microscopy and is available at any season. (2) It can be shipped long distances alive, and be kept alive for weeks in cool laboratory storage. (3) It presents the demanian system of organs—indicative of the fact that nemas possess whole systems of organs as yet comparatively unexplored. (4) It presents all the numerous advantages that well developed free-living forms possess over the parasitic forms commonly used as teaching material, such as, among other things, (a) distinctly developed mouth parts, and salivary glands, (b) caudal glands and spinneret (important and highly characteristic), (c) well developed amphids, (even more highly characteristic and important) (d) sensory setae, (e) readily visible central nervous system, parts of the peripheral system being easily demonstrable by using sea-water-methylene-blue (over night), (f) a more or less visible renette, (g) well developed longitudinal cords, (h) visibly differentiated intestinal cells (among them the "birefringent" cells), (i) a double gonadic system in the male, the *primitive and normal condition,* all your textbooks to the contrary notwithstanding, (j) growth, fertilization, etc., of the *living* ova can be observed in situ; all of these are more or less readily observable without dissection all the better if the nemas are starved first for a day or two in seawater.

Shipping. It is recommended that (1) there be shipped in a separate container, half a liter or so of sea water, since additional pure sea water is necessary as a mounting medium for the living nema and permits renewal, during lengthy laboratory storage, of the sea water containing the nemas; and (2) that the mud containing the nemas be cooled with ice or solid CO_2 outside the container, and be shipped under cool conditions. The nema is so small that hundreds can be packed in the small space suitable to air mail, and this method of shipping is very desirable, especially as air mail temperatures are not likely to be excessively warm. These nemas withstand freezing temperatures.

If the laboratory director, on receipt of the nemas, fixes some of them in formol-acetic-alcohol and then slowly (four rays) evaporates them into glycerine, he will have valuable supplementary material.

SPECIFICITY OF SEXUAL REACTIONS IN THE GENUS OSTREA

Dr. Paul S. Galtsoff

Biologist, U. S. Bureau of Fisheries

Since 1927 the author has been engaged in a study of the factors that control the shedding of eggs and sperm of the eastern oyster, *Ostrea virginica.* In 1929 the opportunity presented itself to experiment with the Japanese oyster, *O. gigas,* grown in Puget Sound, and during the summer of 1930 several experiments were carried out with the Australian oyster, *O. cucullata,* and *O. virginica* grown in the waters near Honolulu, T. H. A complete report of these investigations, comprising nearly four hundred experiments, will be published in the *Bulletin of the Bureau of Fisheries.*

The technique employed in all the experiments consisted in placing the oyster in a tank of about 20 or 30 liter capacity, in which the water was aerated, stirred and kept at constant temperature. In the majority of the experiments the thermoregulators were set at 22.5° C and maintained at this temperature within 0.5°. The oyster was immobilized with plaster of Paris, and one of its valves was attached to a light kymograph lever made of a strip of celluloid. It has been shown in a previous paper (*Proc. Nat. Acad. of Sciences,* 1930, 16, 555-559) that spawning of the female oyster consists of a series of the following reactions: contractions of the mantle, rhythmical contractions of the adductor muscle, and discharge of eggs. Rhythmical contractions of the muscle enable one to obtain a permanent record which can be easily analyzed.

The results of the large number of experiments with *O. virginica* carried out from 1927 to 1929 show that no spawning occurs below 20.0° C. whereas the same specimen reacts to the same suspension of sperm as soon as the temperature has been brought above 20.0°. In a few instances it has been noticed that oysters spawned at 27.5° without being stimulated by sperm. Inasmuch as in those cases unfiltered water was

used, the possibility of its contamination with sperm was not excluded. In the experiments with *O. gigas* it has been found that a ripe female can be induced to spawn by a temperature of 30.0° C. The question naturally arises whether the same results could not be obtained with the other species. During the summer of 1931 experiments were carried out at Woods Hole with ripe *O. virginica* which were kept in aquaria at a temperature of about 20.0°. To avoid possible contamination the water used in the experiments was filtered through a layer of asbestos about three-quarters of an inch thick. The results of the experiments indicate without any doubt that ripe females can be induced to spawn by placing them in water having a temperature from 24.5 to 30.0° C. At 31° the females usually close their valves and remain closed until the temperature drops to 30° or 29°.

The latent periods of spawning reactions, i. e., the time elapsed from the moment the oyster was exposed to a given temperature until the beginning of spawning, varies from 20 to 257 minutes and apparently is not correlated with the temperature, the quickness of the response probably depending on the condition of the organism itself.

The fact that the females can be stimulated by a temperature of 24.5° or higher suggested the possibility that similar effects might be obtained by a longer exposure to temperatures between 20.0 and 24.5°. The results of a long number of experiments, of which only three will be described here, show that this is very doubtful. On July 10, three ripe females were taken from the tank, in which the temperature during the previous week fluctuated between 18.5 and 19.5° C. and placed in an aquarium filled with filtered sea water. The temperature was kept at 22.6°, but occasionally rose to 23.4°. The shell movement of each oyster was recorded on the kymograph. The first oyster was kept for 5 hours and 22 minutes, the second for 29 hours and 53 minutes, and the third one for 73 hours and 13 minutes. The water in the aquaria in which the second and third oysters were kept was changed twice a day. None of the oysters spawned during that time, but each of them spawned after sperm were added to the water, the latent periods being 16, 24, and 15 minutes respectively.

It is interesting to note that in both cases of stimulation, either by the temperature or by the sperm, the reaction is alike and is characterized by a series of rhythmical contractions of the adductor muscle and of the mantle. From that an inference can be made that both factors release some mechanism in the organism of the female which in turn stimulates the muscle and causes the discharge of eggs from the ovary. In this respect the reaction is not specific. It is, however, specific in the sense that sperm of other mollusks (Mya, Mytilus) fail to induce spawning of the oyster. No positive results were obtained also when the sperm of *O. cucullata* was added to the female of *O. virginica* and vice versa.

The spawning reaction of the male consists in a discharge of sperm which is carried away by the stream of water produced by the gill epithelium. The reaction is much simpler than it is in the female; it does not involve the adductor muscle and therefore cannot be recorded on a kymograph. The males respond to the increase in temperature more readily than the females and often spawn in the tanks when the temperature reaches 24°. Similarly to the spawning of the females, the shedding of sperm can be easily provoked by the addition of a few drops of egg suspension or egg water. Unlike the female, in which the latent period lasts for several minutes, the latent period of the spawning reaction of the male is of brief duration. It lasts only a few seconds. The reaction can be repeated many times until the male is spent.

In 1930 several experiments with the two species of oyster, *O. virginica* and *O. cucullata*, were performed at Honolulu. The males failed to respond to the addition of eggs of another species, but immediately reacted by discharging sperm to the addition of eggs of the same species. These results indicate very clearly the specificity of the response of the male to the presence of eggs.

Besides being stimulated by the temperature and egg suspension the males of *O. virginica* can be stimulated also by sperm. In that case the latent period of the reaction is approximately of the same duration as it is in the case of the stimulation of the female. A probable explanation is that the active principle of a sperm suspension, being insoluble in the sea water, acts on the organism through the digestive tract.

From a biological point of view stimulation of spawning either by the temperature or by the sperm and egg suspension is of great interest. It provides a mechanism which insures successful propagation of the species. Should the temperature of the sea water fail to reach the effective point which would induce shedding of eggs by the females, still the spawning of the latter could be provoked by the sperm discharged by the males, which are more susceptible to the increase in temperature. In most of the cases observed by the author, when several oysters were kept together the males spawned first and induced the shedding of eggs by the females. The process, once started, spreads by mutual stimulation of the two sexes throughout the whole oyster bed and results in simultaneous spawning of the oyster population.

ARTERIO-VENOUS ANASTOMOSES

Dr. E. R. Clark and Eleanor Linton Clark
School of Medicine, University of Pennsylvania

Direct connections between arteries and veins, by passages decidedly larger than capillaries, which have been called arterio-venous anastomoses, have been described to our knowledge by Sucquet (1862), Hyett (1864), Hoyer (1877), Pourceret (1885), Grosser (1902) and Grant (1930). There is general agreement that they exist normally in the erectile tissue of the sex organs, in the balls and nail beds of fingers and toes, and in the outer ears of various mammals. While they have been described in other locations, their existence elsewhere has not been established.

The best descriptions of them, made upon injected and fixed material, are those of Hoyer and Grosser. According to them, arterio-venous anastomoses are quite definite structures, ranging in inside diameter from 10 to 50 micra, (except for one in the tip of the bat's wing which may reach a diameter of 150 micra) with a wall which greatly exceeds in thickness that of the arteriole which precedes it. The smooth muscle has, in addition to the usual circular arrangement, an inner longitudinal layer and an outer layer of oblique cells.

Grant (1930), whose studies have paralleled our own, has made interesting observations on arterio-venous anastomoses in the rabbit's ear as seen through the intact skin, and has described their behavior under a variety of experimental conditions.

Our attention was called to them first in the fall of 1929, when we saw them in the type of transparent chambers introduced in the rabbit's ear in which the original tissue is retained, with the original vessels and nerves. They were made accessible to microscopic study by the removal of the cartilage and the skin of the inner side of the ear, and the substitution of a thin sheet of mica. It was found that there are arterio-venous anastomoses normally present in the rabbit's ear to the extent of from forty to fifty in an area approximately 1 cm. in diameter, and the special preparation enabled the observer to make precise observations upon their normal behavior as well as their behavior under experimental conditions for many hours a day, and for weeks or months. It was found that they are definite and, certainly in most cases, permanent structures. Some of them are straight and some are twisted or coiled, occurring singly or in groups of two to eight, with a thick wall which suddenly thins to a single endothelial, non-contractile layer at the venous end which remains wide, giving a funnel-shaped appearance.

In behavior, it has been noted that they are extraordinarily contractile, the most contractile of all the parts of the peripheral vascular system in the ear. The arteries and arterioles of the ear undergo frequent active contractions, usually showing a periodicity of two or three contractions per minute. These general contractions usually involve also the arterio-venous anastomoses. But between such contractions there may be separate contractions of some arterio-venous anastomoses, and it is not uncommon to see an individual arterio-venous anastomosis remain contracted for hours or even days, while a neighboring one may be showing four to eight alternate contractions and dilations per minute.

In addition to the study of arterio-venous anastomoses in the preformed tissue, it has been possible to observe the new formation of definite and permanent ones in new tissue which has grown into an empty space left between the mica and a kodaloid table in a second type of transparent chamber, which we have called the "round table" chamber. In one such specimen installed in July, 1930, taken to Amsterdam for demonstration and brought back to America, four arterio-venous anastomoses were observed in October, 1930. They were watched for several months and during that time showed no evidence of nerve-controlled contraction. In March, 1931, eight months after installation, one of the four showed definite contractions which synchronized with the contractions of the main arteries of the ear. In June, 1931, at eleven months, two others showed similar synchronized contractions. At that time, and in July, the fourth one still failed to show synchronized contraction.

It was possible, with the expert assistance of Dr. E. A. Swenson, to obtain motion pictures of these four arterio-venous anastomoses, of one of them in March, 1931, and of all four in June, as well as motion pictures of similar structures in a second "Amsterdam" rabbit in a chamber installed and cared for by Dr. R. O. Rex in our laboratory. (A reel of motion pictures showing both contracting and non-contracting arterio-venous anastomoses was shown.)

Studies on these interesting structures have only begun, but already many suggestive observations have been made, while the possibilities for the study not only of their function but also of the factors responsible for their formation seem to be unlimited, with the methods for bringing them under observation in the transparent double-walled chambers.

SCIENTIFIC BOOK REVIEWS

Human Heredity. Erwin Baur, Eugen Fischer and Fritz Lenz. Translated by Eden and Cedar Paul. 734 pp. Illustrated. 1931. Macmillan Company. $8.00.

The translation from the German edition of "*Human Heredity*" will be a welcome addition to students and physicians in English-speaking countries, since this book is the best compilation available dealing with heredity in man. The translation is excellent, although a few terms, such as allergies, empathy, and polyhistors, may send even the geneticist to the dictionary. The term "morbific heredity factors" will scarcely recommend itself as good usage when the adjective forms "morbid" and "hereditary" are more familiar.

The first section, written by Erwin Baur, is an elementary account of Mendelian heredity, with emphasis laid on the joint effect of the environment as a factor in the realization of genetic types (phaenotypes). It is not without interest to note that Baur uses the term "natural selection" only as a destructive agent in evolution, bringing about the elimination of the unfit. Its effect in evolution is regarded as entirely negative. It is not suggested that the converse relation, namely, the survival of new, better-fitted mutations, might also be considered as coming under a wider definition of natural selection.

The physical, racial differences in mankind are described in a rather general way by Eugen Fischer. Fritz Lenz brings together a comprehensive list of the "morbific hereditary factors" that are inherited in man. While his treatment is somewhat more critical and conservative than the treatment of this topic by other writers, nevertheless, the same tendency to reach a decision, from inadequate data, as to whether each character is dominant or recessive is manifest. This is especially noticeable in the considerable number of cases described as dominant. It is true that here and there an intimation is given that multiple factors are concerned in the realization of certain types, but the more complex possibilities are not stressed sufficiently. Human material is quite insufficient in many cases to give a convincing answer to these alternatives; but on the whole, this is the most satisfactory and complete account of the inheritance of human structural defects that has yet been brought together.

The section by Lenz dealing with methodology should be read with profit by geneticists dealing with human characteristics. It is an excellent analysis of what the statistical method can and cannot do, and an understanding of the complications involved in this kind of analysis may avoid errors that are not rare in medical literature. In passing, it is curious to take note that nothing is said here of the *actual* method of the experimental treatment of heredity followed by all geneticists, which renders the statistical treatment unnecessary. Since critical genetic work is difficult with human material, the next best resort may be to use such methods as those advocated by Lenz and other statisticians.

The last section of the book, also by Lenz, dealing with the inheritance of intellectual gifts, will probably be read with greater interest by the layman. The treatment here is much in advance of that followed by popular writers in this field, but it will be obvious to those familiar with the more critical treatment of genetic problems demanded by modern standards that only the most superficial description of the subject matter is possible at the present time. Not only is the material quite inadequate, the diagnosis uncertain, the terminology as vague as it is often pompous, but environmental influences play so obvious a rôle in mental disorders as to render a scientific treatment entirely beyond our reach. Lenz has probably handled his subject as well as it could be handled at the present time, but until the different genetic factors can be, to some degree, separated from the environmental, it is a hopeless task to attempt to reach even provisional conclusions. While students of genetics will be inclined to sympathize with Lenz's valiant attempt to ascribe as much as possible to genetics, and to minimize the rôle of chance and environment in leading to success or failure in human development, nevertheless, it is only too obvious that, in the absence of exact measurements and pedigreed stock, little that is really sound is attainable.

—T. H. MORGAN.

Biology in Human Affairs. Edited by Edward M. East. xi + 399 pp. $3.50. 1931. Whittlesey House.

Twelve able contributors have written this book under the editorship of Professor Edward M. East of Harvard University. The editor is to be especially commended for having molded the twelve chapters into a continuously readable book. This is hardly to be said of most of the recent cooperative books.

The first chapter on "Biology and Human Problems" is written by the editor himself. This chapter presents in a clear and forceful style and with telling examples the possible effects of modern biological science upon the remodeling of man's intellectual conceptions. Modern inventions and comforts have recast man's ways of

living almost completely. But science has not yet recast his methods of thinking to anything like the same degree.

It is pointed out that the average mind is still fettered to myths conceived in distant eras of unreason, and actually scientists themselves are sometimes influenced by such myths. As East points out, it is a mistake to assume that when certain eminent physicists, for example, issue preachments in terms of theology and metaphysics they are speaking as scientists. They are merely demonstrating how difficult it is to divest one's mind completely of the whams and whimseys learned in early childhood. A strong case for the advantages of simple scientific truth is built up in a most interesting fashion.

Eash chapter of this book is well worth reading, but certain chapters are particularly well presented. Dr. L. M. Terman's chapter on "Educational Psychology" presents this subject in a simple and fascinatingly clear way. Professor H. M. Parshley discusses "Zoology and Human Welfare" in a clearly analytical and instructive style. The last chapter on "Diet and Nutrition," by Professor McCollum, forms valuable reading for all persons. The other chapters are all very well done, though space does not permit a particular reference to them.

The only shortcoming which one might feel after reading this very satisfying book is that some form of summary or concluding statement might have been good to round off the various subjects for the general reader. Professor East is to be congratulated on the success of his undertaking. —C. R. Stockard.

Plant Life through the Ages. A. C. Seward. xxi + 601 pp. 140 figs. + frontispiece. 1931. Macmillan. $10.00.

The imperfection of the geological record is felt more strongly by botanists than by zoologists. The swarming shell fish of the Cambrian have no counterpart among plants at the same level. The record, therefore, is extremely fragmentary among plant groups below the ferns.

The higher archegoniates and seed plants, on the other hand, are abundantly and well preserved at many horizons, though the lack of compactness in the plant body has led to some serious errors of interpretation. Parts belonging together are often scattered in the process of fossilization. Thus, one species may be considered as Lepidodendron (stem), Stigmaria (root), or Lepidostrobus (reproductive cone). At the same time some unexpected associations are found, as in a dominant group of the Carboniferous, the Pteridosperms, where the leaf of a fern carries seed rather than sporangial sori.

It is, therefore, not surprising that the fossil record is complex and confusing. It has never been possible to draw from the evidence of paleobotany the sort of connected story of the grand ascent of organisms through the ages that is familiar to the zoologist.

The writings of paleobotanists are reflected from their material. Much of it is properly technical, and there have been only a few successful attempts to summarize for the general reader the rich findings of the last twenty years, in which British and American botanists have been leaders. Berry, in this country, and especially Seward, in England, have done the best work along this line. The present volume sets forth for the first time the whole story of plant evolution so far as the fossil record has revealed it. The geological background, the fossils themselves, and their interpretation, are clearly presented.

The author is conservative on controversial subjects such as Wegener's hypothesis and the question of past climates as revealed by plant distribution, but does not hesitate to take a firm stand on such matters as the supposed occurrence of Angiosperms in the Carboniferous, the existence and approximate bounds of the former great continent, Gondwanaland, or the origin of boghead coal.

The book is adequately illustrated. Reconstructions of landscapes by Edward Vulliamy form a valuable contribution for orienting the reader among the details of fossil forms. Especially satisfying is the clear treatment of Devonian land plants, of which much has been learned in recent years. This is a good book. much needed. —I. F. Lewis.

Textbook of Experimental Cytology. James Gray. 516 pp. Illustrated. 1931. The Macmillan Co. $7.50.

This book is an important contribution to biological literature. We have several textbooks of cytology which are primarily morphological, but none which gives a general survey of cellular structure and function from the standpoint of the experimentalist. Mr. Gray's book fills this gap.

As the author states in his preface, "the present book represents the substance of a series of lectures delivered in Cambridge for some years past." It is an analytical study of living processes obtained by the experimental method in contrast with the inductive morphology of the past century.

In the early days when the living cell was first recognized as the functional and structural working unit of vital phenomena, investigators were keenly interested in applying experimental methods to its study. Of historic interest is the fact that there exists a considerable gap in time between

the work of these earlier investigators and the more recent contributions to the subject. The recent renewed activity is probably due to new methods of approach made possible not only by the development of new technique, but also by the advances in physical chemistry which have rendered possible the application of these newer principles to problems of cellular activity.

There exists a real danger in the present day trend of reducing the various phases of vital phenomena to terms of physical chemistry as we know them today. One reason for this is that our knowledge of many pertinent physico-chemical phenomena is still very imperfect. Another reason lies in the extraordinary diversity in the reaction of different types of living cells to experimental conditions. In addition, a prevailing shortcoming is the generalization of results obtained from experimentation with one or a few types of cells to all units of living matter. This complexity makes an interpretation and a well-reasoned presentation of the subject a difficult task.

The author of this book is well equipped for such a task in being versed not only in modern physical chemistry, but also in straight-forward conventional cytology. He strikes a happy medium in presenting a conception of protoplasmic structures and behavior based on a well digested survey of present day knowledge on the subject. The subject of cytology treated experimentally is full of gaps and controversial points. We therefore appreciate the fact that Mr. Gray has not limited himself to a mere compilation but has, from his first hand knowledge of many phases of the subject, made frequent critical analyses of the problem raised.

The numerous illustrations and tables are well selected, the style is lucid and concise. In short, the author is to be highly commended in having produced a book which is sufficiently detailed and yet sufficiently non-technical to be read with interest and profit alike by the biologist, physicist or chemist who may desire to obtain a conception of what is known regarding cell structure and the functional relation of the cell to its environment. —Robert Chambers.

Textbook of Human Embryology. Cleveland Sylvester Simkins. xiv + 469 pp. 263 illustrations, some in colors. 1931. F. A. Davis Co.

This newest textbook of human embryology is a distinctly ambitious attempt to place all essential data of human development within the compass of a single volume. It is copiously illustrated, and the illustrations are clear and on the whole well chosen from recent original studies. Some attempt is made to cover the functional as well as the purely anatomical aspects of development. As in all descriptions of human embryology, the blanks are filled in from studies of other mammalian material.

The chief fault of the book appears to the reviewer to lie in its very ambitiousness. For most students, too detailed description is apt to lead to confusion, and details of interest to investigators can best be sacrificed to a concise treatment. For instance, 55 pages devoted to the development of the urogenital system appear to exceed the limits of a usable textbook. Since the book cannot be considered a definitive reference work, so lengthy a treatment apparently justifies the charge of excessive wordiness.

Probably the least successful section of the book is the brief account of maturation and fertilization. It will be impossible for a student to secure an accurate picture of these processes from such grossly misleading statements as "——each chromosome of the bivalent group is further reduced to a tetrad" (page 23). In view of the conclusive work of Painter and of Evans and Swezy, there can be little excuse for Figure 12, in which the diploid chromosome numbers are given as 23 and 24, in spite of the illuminating sentence concluding the legend below, that "there are 48 chromosomes in the eggs and sperms of man". It is unfortunate that before publication the author did not submit this chapter to some one familiar with cytology.

With so many excellent general and special textbooks of embryology available, it seems difficult to justify the labor which has gone into the preparation of Dr. Simkins' volume. It is certain to require extensive revision.

—H. H. Plough.

Progressive Relaxation. Edmund Jacobson. xii + 430 pp. 69 figs. 1929. The University of Chicago Press.

Following a short discussion of the status of rest and relaxation in modern medicine, the author presents in detail the technique of his method for general and differential relaxation. The influence of relaxation upon the reflexes and the mental activities of human subjects is cited. The physiology of the emotions, muscular contraction and tonus, augmentation and related phenomena are reviewed with reference to the problem of relaxation. That progressive relaxation must not be confused with suggestion or hypnosis is indicated. While the author does not pretend that progressive relaxation is a panacea, case histories of its therapeutic use in diverse medical conditions, notably spastic esophagus and mucous colitis, are given. This book should be of interest to the physician, the psychologist, and the physiologist.

—*Walter S. Root.*

Die Sexuellen Zwischenstufen. (*Sex Intergrades*), Richard Goldschmidt. (Monographien aus dem Gesamtgebiet der Physiologie der Pflanzen und der Tiere 38.) 528 pp. 214 fig. 1931. Julius Springer.

Goldschmidt's book is a comprehensive work on sex intergrades in animals. The term sex-intergrade is used in contrast to the normal condition which is considered to be that of "Zweigeschlechtigkeit", the two sexes in different individuals. The word "Bisexualitat" is avoided because of ambiguity, since it sometimes suggests two sexes in the same individual, "Doppelgeschlechtigkeit". All true hermaphrodites, as in Annelids, snails, etc., are excluded from the class "sex-intergrades". An intersex "has in the course of its life a male and a female phase, of which only one or neither is functional". There were previously distinguished three possible types of sex-determination, (1) progamic—before fertilization; (2) syngamic—during fertilization; (3) metagamic—after fertilization. The first type is very questionable except possibly for the peculiar case of Dinophilus. The last type is also much more restricted than has been supposed. The second type, syngamic or zygotic, does not mean that establishment of sex is unchangeable. Primary sex may be determined at fertilization. The animal develops as this sex up to a certain stage; then there comes the turning point after which development is according to the opposite sex. All parts of the body are genotypically similar but differ from the point of view of developmental physiology. The turning point may be determined either zygotically, by hormonal action, or by external conditions. In the case of diploid zygotic intersexuality there is no disturbance of the chromosomal basis of sex-determination but in the case of triploid zygotic intersexuality there is considerably irregularity in chromosome number.

Four hundred and sixteen pages are devoted to intersexuality of which 179 deal with invertebrates. Gynandromorphism is discussed in 46 pages of which 41 deal with insects. Gynandromorphs are defined as genotypic sex-mosaics in space, while intersexes are phenotypic sex-mosaics in time.

All who are interested in problems of sex-determination will find this book fascinating reading. Professor Goldschmidt's German is never too involved for the English speaking reader. The material is well classified so that it is very easy to find discussion of the various principles involved and of the species upon which experiments have been performed. An excellent bibliography adds much to the value of the work.

—P. W. Whiting.

Demons of the Dust: A Study in Insect Behavior. William Morton Wheeler. xviii + 378 pp. Illustrated. 1930. W. W. Morton and Co. $5.
[Structure and Behavior of Ant-Lions, and of Some Analogous Insects (Flies)]

Under the rather cryptic title, "Demons of the Dust",—alleviated, however, by the sub-title, "A Study in Insect Behavior", Professor William Morton Wheeler of Harvard University presents a well illustrated and interesting book containing: 35 pages of bibliographical accounts of some noted eighteenth century entomologists, with very attractive portraits; 40 pages concerning the fauna of desert sands; 60 pages of observations on ant-lions; 134 pages on what he calls worm-lions,—pit-building predatory dipterous larvae; and about 100 pages embodying (a) his conclusion, (b) some appendices, (c) an extensive bibliography, and (d) an excellent index.

It is the most complete book on its subject, and the fact that it is prepared by Professor Wheeler is a sufficient guarantee that it is interesting and accurate. Among the most entertaining moments are those in which the author adverts to the foibles of the rest of us. One notes with appreciation that more than the usual amount of attention is given to the *internal* anatomy, histology and physiology of these insects, small though that amount be. The title is likely to be troublesome to the indexers, but indexers are used to trouble, and perhaps will not mind a little more. One is reminded of the ambitious young husbandryman, who, anxious about his flocks, sent to the local library for a book entitled "Sheep Folds", and received in return a religious work devoted to "flocks" of a very different kind. The book is well printed and attractive. —N. A. Cobb.

A Survey of National Trends in Biology. Edward J. V. K. Menge. xi + 156 pp. $2.00. The Bruce Publishing Company. 1930.

This is a series of lectures surveying national trends in biology based upon replies to questionnaires sent to leading biologists of various nations. The lectures were prepared for the National University of Cordoba and for the Sociedade de Medicina e Cirurzia de Rio de Janeiro.

The author gives a very brief account of the development of the various fields of biology, some of the outstanding present day theories, and their effects upon our philosophical conceptions of living organisms. The treatise has a decided philosophical atmosphere and emphasizes the barrenness of the idea that a living organism is nothing more than a series of chemico-physical phenomena of the various elements of protoplasm and of the morphological units of the organism. It reads well and in interesting.

—C. L. Parmenter.

Starling's Principles of Human Physiology. 5th edition. Edited and revised by C. Lovatt Evans, and H. Hartridge. xv + 1039 pp. 543 illustrations. $8.50. Lea and Febiger. 1930.

A textbook as well known as the above requires no detailed review. Following the death of Professor Starling, the present edition has been placed in the hands of Professor Lovatt Evans and Professor Hartridge. This is sufficient guarantee that the high merit of previous editions is maintained. While the general size and plan of previous editions has been retained, the book has been thoroughly revised, nearly every page showing some alteration, and many sections being entirely rewritten. It may be safely recommended as one of the best textbooks in this field. —F. P. KNOWLTON.

Jane's Island. Marjorie Hill Allee. 236 pp. 10 illustrations. $2.00. Houghton Mifflin Company.

"Jane's Island," by Marjorie Hill Allee, is a book which should interest every one in Woods Hole, because the story centers around the Marine Biological Laboratory. It is a story which has been written for girls from twelve to sixteen years of age, but because of its local atmosphere it will be read by older people as well. For example, the author has called Captain Veeder and the Cayadetta by their actual names. Among the ten pen and ink sketches, many people will recognize familiar scenes, and the map of Woods Hole and the Elizabeth Islands on the inside front cover will be of especial interest to them.

The author has spent many summers at Woods Hole, and her husband, Professor Warder C. Allee, is working at the laboratory this summer. For several years before 1922 he was in charge of the course in invertebrate zoology.

The Nature of Living Matter. Lancelot Hogben. ix + 316 pp. $3.75. Alfred A. Knopf.

This book comes as a relief to biologists who have grown weary of hearing physicists and astronomers express themselves learnedly on various aspects of philosophical biology. Professor Hogben is a competent biologist, and much of what he says will appeal to workers in the field of biology. The book is clearly and forcibly written and it is interesting throughout.

In some of the early chapters, Hogben considers the conflict between vitalism and mechanism, and his points are well taken. A quotation will show the general style of the book better than any lengthy description.

"There is...no justification for a dogmatic assertion that all the properties of living matter will eventually be reduced to the same hypotheses as are adopted in physical chemistry. But it is doubtful whether any biologists of the mechanistic persuasion have on any occasion explicitly committed themselves to so rash a statement. The vitalistic Sarah Gamp has invented a mechanistic Mrs. Harris with the express object of giving her a piece of her mind. As a polemical device this is most valuable, especially in political propaganda. It does not help the mechanist to understand what vitalism can offer as a guide to further biological enquiry. His perplexity is increased by the circumstance that so many vitalists of the platform behave themselves with mechanistic propriety in the laboratory. Dogmatism is at least as frequent among those who call themselves vitalists as among mechanists...."
—Unsigned.

The Terpenes. J. L. Simonsen. Volume I. XI + 420 pp. $8.50. The Macmillan Company.

This is the only English book dealing with the chemistry and structure of the terpenes. The first volume for want of space deals only with the more simple acyclic and monocyclic terpenes, but the author promises to complete the series with a second volume dealing with the dicyclic terpenes and the sesquiterpenes.

The first part of the book deals with the more simple acyclic and the second with the monocyclic terpenes. The individual members are then further classified with reference to the predominating functional groups. The author gives for each terpene the occurrence, the more common physical properties and a discussion of the chemical properties along with the historical development of the structural formula. The author has for some time been an active investigator in this field and his presentation of the development is especially interesting. A complete list of references accompanies each discussion.

The book is hardly to be recommended to the general reader, but to the organic chemist as a reference book in this field and as a source of methods used in developing this branch of chemistry it should prove invaluable.

—JOSEPH B. HALE.

An Introduction to Neurology. C. Judson Herrick. Fifth Edition. Revised. W. B. Saunders Company. 1931.

All students of neurology will welcome the fifth edition of this very excellent text. It is too well known to need comment. The present edition has been carefully revised and brought up to date and maintains the high standing of the earlier imprints. —G. H. PARKER.

THE VOYAGE OF THE ATLANTIS

Columbus Iselin, *Captain*

The motor ketch, *Atlantis*, the principal instrument for research of the Woods Hole Oceanographic Institution, docked at Woods Hole at six o'clock on Monday evening, August 31, having completed a cruise of over four thousand miles.. The *Atlantis* is a Diesel auxiliary ketch of about 410 tons' displacement. She is 142 feet in length and has a beam of 29½ feet. She draws 17 feet of water. Ordinarily, sails are used to move the vessel, and the sail area has 7,200 square feet of canvas. When the wind is too light, there is a 280 horse power Diesel engine which can be brought into use. During the cruise just completed the vessel was under power perhaps one-third of the time. This engine also supplies the power for the main trawl winch. The electricity for lighting and ventilation is generated by a twenty-five horse power crude oil motor which is located amidships in the engine room. Electrical power is also available for hoisting and trimming the sails. The vessel can carry about twenty tons of fuel oil and forty tons of fresh water. This is enough to enable her to remain at sea about three months.

Below decks the cabin arrangements are simple. In the stern there is a chart room, and the captain's cabin, and three cabins for the scientific staff. The two laboratories are situated farther forward, one being for the biological work and the other for the chemical work. Amidships is a hold for the storage of sails and rigging, and below this is the main trawl winch, which weighs about twenty-two tons and holds five thousand fathoms of half-inch wire cable. Because of its weight, the winch had to be placed low down in the vessel. The hydrographic winch, which can handle an equal length of lighter cable, is placed on deck next to the mizzen mast. Over the engine room are the cabins for the ship's officers. The mess room for the officers and scientists is forward of these officers' cabins. Next comes the galley, and then the crew's mess room and the forecastle.

The *Atlantis* left Copenhagen on July 7 and after six days reached Plymouth, England. Here some apparatus was taken aboard and a few final adjustments made on the rigging and machinery. On July 16 she left Plymouth and headed for a point in mid-ocean about opposite the coast of northern Ireland. Then she turned south, making a hydrographic section over one thousand miles in length which traversed the branches of the gulf stream and reached nearly to the equatorial current.

On this section, besides hydrographic work, each day at noon a light intensity station was made, and whenever possible in the evening the nets were put over for collecting eel larvae. This work on the eels was done for Professor Johannes Schmidt of the Carlsberg Laboratory at Copenhagen. For many years he has been interested in the migration of the young eels which are born south of Bermuda and must spend two years swimming eastward towards European rivers. Dr. Franz Zorell of the Deutsche Seewarte in Hamburg was in charge of the hydrographic and chemical work. He collected extensive data which will be of great help in the study of the circulation of the North Atlantic. All water samples were analyzed both for salinity and oxygen content.

After reaching thirty-seven degrees north latitude, the *Atlantis* again turned west and crossed the ocean in the Horse latitudes. On this sector deep temperature stations (down to 4000 meters) were made each day and also further experiments with light intensity observations and simultaneous plankton hauls. Dr. George Clarke and Mr. Raymond Montgomery were in charge of this part of the work, and an attempt was made to correlate the vertical migrations of the plankton with light intensity throughout the twenty-four hours.

After reaching a point just north of Bermuda, the *Atlantis* headed northwest towards the coast of Nova Scotia. This section traversed the gulf stream, and further hydrographic stations were made at thirty-mile intervals. Once inside the gulf stream, another series of observations were made on the vertical migrations of the plankton, because in this region of colder water the more abundant life made it easier to get definite results quickly.

During most of the cruise a meteorological program was also carried out. This was aimed, first, to secure evaporation and rain-fall measurements, and secondly, by means of electrical resistance thermometers situated along the mast, to study the stability of the lower layer of the atmosphere. On three occasions experiments were also made with different kinds of deep sea tow nets. The trouble with deep sea towing has been that the catch, in general, reaches the surface in poor condition. The *Atlantis* found that, by using very large nets and by having a metal bucket in their small end, the specimens could be brought to the surface in reasonable shape.

It took forty-one days to reach Boston, and although the scientific program was rather varied, the main object of the trip was achieved. The instruments and machinery have been thoroughly tested, and in October the ship will be ready to put to sea for more intensive work.

Besides the four cruises planned for the study of seasonal variations in the sector between Cape Hatteras, Bermuda and Nova Scotia, the *Atlantis* plans each year to make three other cruises, one of which will last about two months.

MOTION PICTURES OF THE AFRICAN EXPEDITION

On Friday, August 28, Professor J. H. McGregor of Columbia University showed several reels of motion pictures taken in equatorial Africa by the recent expedition sent out by Columbia University and the American Museum of Natural History. The personnel of the expedition included Mr. H. C. Raven, who in view of previous experience in African zoological collecting was appointed director, Professors William K. Gregory, J. H. McGregor and E. T. Engle.

The object of the expedition was to secure well preserved material for anatomical study of the two great African anthropoid apes, the chimpanzee and the gorilla, but especially the gorilla, the anatomy of which is by no means fully known. Five adult gorillas were obtained, two of the eastern highland type from the volcanic mountains near Lake Kivu in the eastern part of the Belgian Congo, a variety or species first discovered in 1903, and three of the better known West African gorillas. The latter were killed in the Cameroon. All these animals were embalmed by arterial injection for anatomical study, and detailed discussion and comparison with human anatomy have already been begun. It is hoped that comparative studies may throw light on the interrelationship of the west coast and mountain forms, and show definitely whether the mountain gorilla is a valid species or merely a local variety.

The motion pictures taken by the expedition show the habitat of the mountain gorilla, and certain phases of the preparation of the dead bodies. Four young captive gorillas were the subjects of one reel, and others showed various aspects of native life, Congo scenery, etc.

FINAL SCIENTIFIC MEETING

Thursday, September 3, 1931.

(All papers limited to 10 minutes)

Part I. 9:00 A. M.

1. Dr. Charlotte Haywood and Dr. Walter S. Root, "The Cleavage Rate of the Arbacia Egg in the Presence of Carbon Dioxide and Bicarbonate."

2. Dr. Arthur K. Parpart and Dr. M. H. Jacobs, "The Action of Acetic Acid and its Sodium Salt on the Cleavage of Arbacia Eggs."

3. Mr. K. Dan, "Cataphoretic Studies of Marine Eggs."

4. Dr. Kenneth Cole, "Surface Forces of the Arbacia Egg."

5. Dr. E. N. Harvey, "The Tension at the Surface of Arbacia Eggs, Determined by Centrifugal Force."

6. Dr. Ethel Browne Harvey, "Development of Arbacia Half-Eggs Produced by Centrifugal Force."

7. Dr. Balduin Lucke, "Osmotic Properties of 'Fragments' of Arbacia Eggs Obtained by Centrifugal Force."

8. Dr. M. H. Jacobs and Dr. Dorothy R. Stewart, "A Method for the Quantitative Measurement of Cell Permeability."

9. Dr. Dorothy R. Stewart and Dr. M. H. Jacobs, "The Effect of Fertilization on the Permeability of the Arbacia Egg to Ethylene Glycol."

Intermission

Part II. 11:15 A. M.

1. Dr. Miriam Scott Lucas, "Recent Observations upon a Type of Fission Undescribed for Ciliates."

2. Dr. E. C. Cole, "Selective Intra-Vitam Staining of Specific Elements in the Integument of the Squid."

3. Dr. C. C. Speidel, "Types of Nerve Regeneration, as Revealed by Prolonged Observations of Individual Fibers in Living Frog Tadpoles."

4. Dr. H. H. Johnson, "Centrioles and Other Cytoplasmic Bodies in Living Cells of Gryllids."

5. Dr. P. W. Whiting, "Genetic Results in Habrobrachon Bearing on Maturation and Fertilization."

Intermission

Part III. 2:00 P. M.

1. Mr. L. V. Beck and Mr. D. E. Green, "Oxidation-reduction Potentials of Cytolyzed and Intact Echinoderm Eggs."

2. Dr. Eric G. Ball, "Hemolysis of Fish Erythrocytes by an Impurity in Sodium Chloride."

3. Dr. G. H. A. Clowes, Dr. I. H. Page and Mr. H. A. Shonle, "On the Contrasting Cytolytic Effects Exerted by Soaps of the Type of Sodium Ricinoleate and Sodium Oleate at Different H Ion Concentration and the Relation of these Effects to the Oil-water Interfacial Tensions Exerted by the Soaps in Question."

4. Miss Anna Keltch, Miss Ilene Harryman and Dr. G. H. A. Clowes, "Influence of H Ion Concentration on the Anaesthetic Value of a Series of General and Local Anaesthetics and Hypnotics."

5. Mr. S. A. Corson, "The Action of Acid and

Alkali on the Protoplasmic Viscosity of Amoeba dubia."

6. Mr. H. B. Steinbach, "The Effect of Salts on the Injury Current of Scallop Muscle."

7. Dr. Robert Chambers and Mr. D. A. Marsland, "The Action of the Common Salts on the Protoplasm of the Echinoderm Egg."

8. Mr. Morris Belkin, "Capping of Oils on Protoplasmic Surfaces."

Demonstrations

Part IV. 3:45 P. M.

Mr. David M. Ashkenaz, "The Effect of Sodium and Calcium Chlorides on Changes in Penetrability of Neutral Red." *Physiology Lab., O. M. B.*

Dr. Eric G. Ball, "Hemolysis of Fish Erythrocytes by an Impurity in Sodium Chloride." Room 110.

Mr. Morris Belkin, "The Capping Phenomenon in Amoeba dubia." Room 328.

Dr. C. B. Bridges, "Apparatus and Designs for Raising Drosophila." Room 324.

Dr. E. R. Clark, Mrs. Clark, Dr. H. T. Kirby-Smith and Dr. W. J. Hitschler, "Living Tissues as Seen in Transparent Chambers Introduced into the Rabbit's Ear." Room 117.

Dr. E. C. Cole, "Selective Intra-vitam Staining of Specific Elements in the Integument of the Squid." Room 24, O. M. B.

Dr. Kenneth Cole, "An Egg Crusher." Room 209.

Dr. E. N. Harvey and Dr. E. B. Harvey, "Arbacia Half-cells (Fertilized and Unfertilized) Produced by Centrifugal Force." Room 116.

Dr. H. H. Johnson, "Centrioles and Other Cytoplasmic Bodies in Living Cells of Gryllids." Room 315.

Dr. Miriam Scott Lucas, "Demonstration of Fission of Cyathedidinium piriforme." Room 224.

Dr. C. W. Metz, "Demonstration of Chromosomes of Sciara." Room 344.

Dr. A. E. Navez, "Cardiac Frequency of Anomya as a Function of Temperature." Room 110.

Dr. Nellie M. Payne, "The Effect of Temperature upon the Duration of "Death Feigning." Botany Building, 2nd floor.

Mr. F. J. M. Sichel, "Apparatus for Studying Tension in Isolated Muscle Cells." Room 337.

Dr. C. C. Speidel, "Nerve Sprouts, Sheath Cells and Myelin Segments in Living Frog Tadpoles." Room 106.

Dr. Anna R. Whiting, Miss Magnhild M. Torvik, Mrs. Lysbeth H. Benkert and Miss Kathryn A. Gilmore, "Exhibit of Mutants and Mosaics in Habrobrachon." Rockefeller, Room 7.

EXHIBIT OF INVERTEBRATE ANIMALS COLLECTED BY THE INVERTEBRATE ZOOLOGY CLASS IN THE VICINITY OF NORTH FALMOUTH ON AUGUST 28, 1931

Dr. James A. Dawson

Director of the Course in Invertebrate Zoology

An exhibit of representative species of invertebrate animals was placed in the main entrance hall of the new Brick Building of the Marine Biological Laboratory by the staff and members of the invertebrate zoology class for the benefit of those workers at the laboratory who wish to familiarize themselves with the common species of the region. This collection of one hundred and sixteen different species gives a fair picture of the invertebrate fauna of this collecting ground, which is the richest in species of any place visited by the invertebrate zoology class. Such a collection, unfortunately, gives no idea of the relative abundance of individual animals. A fair idea of the abundance, however, can be had by stating the number of teams reporting any given species. In the following list animals which were reported by all teams, six in number, are marked with an asterisk immediately before the name of the animal. In the case of animals less abundant the number of teams reporting them is placed in brackets immediately after the name of the animal. On this trip one hundred and forty-five species were reported in all, individual teams reporting from one hundred to one hundred and twenty species. A check list showing the animals which are more or less frequently taken by the invertebrate zoology class was placed on the tables. It is perhaps worth while stating that the composite list made up in the same way for all regions visited by the invertebrate zoology class during the years 1922 to 1931 inclusive is to be placed on file in the Library.

In the following list of the animals placed on exhibition names of animals in various phyla are given alphabetically in the different classes, subclasses, and in some cases, in the orders also.

PORIFERA: Class Calcarea: *Leucosolenia botryoides* (3). Class Demospongia: *Cliona celata* (5), **Halichondria panicea*, **Microciona prolifera.*

COELENTERATA: Class Hydrozoa: *Clytia johnstoni* (3), *Hydractinia echinata* (5), *Schizotricha tenella* (4), **Sertularia pumila.* Class Anthozoa: *Edwardsia elegans* (4), *Eloactis producta* (1), **Sagartia leucolena*, **Sagartia luciae.*

PLATYHELMINTHES: Class Turbellaria: *Bdelloura candida* (2), *Eustylochus ellipticus* (1).

NEMERTINEA: *Cerebratulus lacteus* (2).

ANNELIDA: Class Chaetopoda: Subclass Polychaeta, Order Nereidiformia: *Arabella opalina* (5), *Diopatra cuprea* (5), *Glycera americana* (4), *Glycera dibranchiata* (5), *Lumbrinereis sp.* (4), **Nereis virens*, *Phyllodoce catenula* (3), *Scoloplos fragilis* (1), **Scoloplos robustus*, **Sthenelais leidyi*, Order Spioniformia: *Laonice viridis* (5). Order Terebelliformia: *Amphitrite ornata* (2), **Cistenides gouldi*, *Enoplobranchus sanguineus* (4), *Pista palmata* (1), *Polycirrus eximius* (4). Order Scoleciformia: *Arenicola cristata* (3), *Arenicola marina* (5), **Clymenella torquata*. Order Sabelliformia: **Hydroides hexagonus*, **Spirorbis spirorbis*. Class Gephyrea: **Phascolosoma gouldi*.

ARTHROPODA: Class Crustacea, Order Cirripedia: **Balanus balanoides*, **Balanus eburneus*, **Chthamalus fragilis*. Order Amphipoda: *Lepidactylus dytiscus* (2), **Orchestia platensis*, *Talorchestia longicornis* (3). Order Isopoda; *Cyathura carinata* (2), *Erichsonella filiformis* (2), *Janera marina* (5). Order Mysidacea; *Heteromysis formosa* (1). Order Decapoda: *Callinectes sapidus* (5), **Carcinides maenas*, **Crago vulgaris*, *Emerita talpoida* (5), **Hippolyte zostericola*, *Libinia dubia* (5), **Neopanope texana*, *Ovalipes ocellatus* (5), **Pagurus longicarpus* (5), *Pagurus pollicaris* (5), **Palaemonetes vulgaris*, *Pelia mutica* (2), *Pinnixa cylindrica* (3), **Uca minax*, **Uca pugnax* Subclass Xiphosura: *Limulus polyphemus* (5).

MOLLUSCOIDEA: Class Bryozoa: *Aetea anguina* (2), **Bugula turrita*, *Bugula gracilis* (1), *Crisia eburnea* (3), *Flustralla sp.* (5), **Lepralia pertusa*.

ECHINODERMATA: Class Asteroidea: **Asterias forbesi*. Class Ophiuroidea: **Ophioderma brevispina*. Class Echinoidea: *Arbacia punctulata* (3). Class Holothuroidea: **Leptosynapta inhaerens*, *Thyone briareus* (4).

MOLLUSCA: Class Amphineura: *Chaetopleura apiculata* (3). Class Pelecypoda: **Anomia simplex*, *Arca campechiensis* (2), *Arca transversa* (5), *Cumingia tellinoides* (4), *Ensis directus* (5), *Gemma gemma* (2), *Gemma manhattensis* (1), **Laevicardium mortoni*, *Macoma sp.* (2), *Modiolus modiolus* (4), **Mya arenaria*, **Ostrea virginica*, **Pecten gibbus borealis*, *Petricola pholadiformis* (3), *Pholas sp.* (2), **Solemya velum*, *Tellina tenera* (5), **Teredo navalis*, *Turtonia sp.* (2), **Venus mercenaria*. Class Gastripoda, **Bittium alternatum*, *Busycon canaliculatum* (5), **Columbella avara*, **Columbella lunata*, **Crepidula fornicata*, **Crepidula glauca convexa*, **Crepidula plana*, *Doris sp.* (3). **Littorina obtusata palliata*, **Littorina rudis*, **Melampus lineatus*, *Odostomia sp.* (5), *Polinices duplicata* (5), **Urosalpinx cinereus*.

CHORDATA: Subphylum Hemichorda: **Dolichoglossus kowalevskyi*. Subphylum Urochorda: **Amaroecium constallatum*, **Botryllus schlosseri*, *Molgula manhattensis* (4), *Perophora viridis* (3), **Styela partita*.

RESEARCH REPORTS OF INVESTIGATORS HOLDING SCHOLARSHIPS

Last Fall the five Collecting Net Scholarships of $100.00 each were awarded to the following students:

Miss Elizabeth M. Heiss
Dr. Frank R. Kille
Mr. David E. Greene
Mr. Seymour Farber
Mr. Robert Pitts

Messrs. Farber and Pitts were unable to come to Woods Hole this summer.

We have the privilege of printing below a brief outline of the work accomplished by the three investigators who carried out their work at the Marine Biological Laboratory during the present summer with the assistance of the grant from The Collecting Net Scholarship Fund.

DISTRIBUTION OF UROSALPINEX CINEREUS AND THAIS LAPILLUS

An experiment which had its inception in the Invertebrate Zoology Course was conducted to test the traveling ability of certain adult gastropods. During the first week of September, 1930 about two thousand shells of *Urosalpinx cinereus*, the oyster drill, living in a certain restricted area at Nobska were marked for identification with red lacquer and replaced in the exact location from which they had been taken. At the same time about five hundred individuals of another less common species, *Thais lapillus*, were also collected and marked. At the end of a year, the marking, though somewhat eroded by wave action and weathering showed distinctly and systematic collections were made of the marked animals. Over twenty-five per cent of the experimental *Urosalpinx* were recovered from the surfaces of rocks exposed at low tide within twenty feet of the rock on which they had been placed twelve months before. About one per cent were found on rocks about one hundred feet away but no marked snails were seen at a greater distance from the experimental area although the adjacent coastline was collected over several times. A great many more *Urosalpinx* were noted early in the summer than could be found in late August when the chosen period of a year was over. This may be due either to death and subsequent dropping of the empty shell to the ocean floor or to

submergence under large masses of algae which have grown up during the summer. Of the *Thais lapillus* only one marked specimen was found during the entire summer.

Taking into consideration mortality and unrecovered living snails, it seems apparent that adult *Urosalpinx* has little tendency to migrate, but in the case of *Thais* no conclusions can be drawn. All of the recovered individuals and in addition new unmarked specimens collected in the same restricted region were then freshly painted in order to continue the study for another year.

A second experiment has been pursued on the stimulating effect of crowding on the cleavage of echinoderm eggs, and this will be continued during the summer of 1932.

—*Elizabeth M. Heiss.*

ANATOMY AND REGENERATION IN THYONE

It was shown by the work of A. S. Pearse* and J. W. Scott† that the holothurian, *Thyone briareus,* will undergo extensive autotomy, including tentacles, lantern, oesophagus, stomach, intestine, water-vascular ring, Polian vesicle and nerve ring, and may regenerate all of these organs. The present study is concerned with (1) the stimuli which will induce self-mutilation, (2) the origin and description of the regenerated tissues, and (3) the effect of restricted cloacal pumping upon regeneration.

Immersion in dilute solutions of the hydroxides and carbonates of potassium and sodium, and electrical stimulation applied to the muscles of the body wall, brought about autotomy. The best results were obtained by immersing the Thyone in very dilute ammonia water (1 part 7N NH_4OH:800 parts sea water). Autotomy took place within 30 seconds. The animal was then transferred to fresh sea-water. 150 Thyone were eviscerated by the ammonia method. In 96 per cent of the possible cases the animals lived until killed for examination of the regenerated parts.

Having this satisfactory method of inducing evisceration, it has been a simple matter to obtain Thyone in any stage of regeneration. A study of the regenerated tissues is now in progress.

In Thyone the respiratory trees are attached to the cloaca. These organs are supplied with fresh water taken in through the cloaca. The posterior ends of 12 Thyone were sewed shut immediately following autotomy. These animals were all dead at the end of four days. A comparison is being made of the rate of regeneration in these animals deprived of the function of the respiratory trees with the rate in those animals having full use of these organs.

* Pearse, A. S., '09, Autotomy in Holothurians, Biological Bulletin, Vol. XVIII, No. 1.

† Scott, J. W., '14, Regeneration, Variation and Correlation in Thyone, American Naturalist, Vol. XLVIII.

—Frank R. Kille.

EFFECT OF SULFHYDRAL COMPOUNDS ON THE RATE OF CLEAVAGE

F. S. Hammett on the basis of a considerable body of evidence advanced the theory in 1929 that sulfhydral compounds are chemical stimuli for cell division.

We tried to test out this theory using the eggs of Arbacia as our material. If was first necessary to perfect a technique which would permit of measuring small differences in the rate of cleavage. By carefully controlling the temperature and the concentration of eggs, by using eggs from only one female and by making counts of 1000, we were able to detect a statistically significant difference of 5% between the percentage cleaved in control and experimental.

One and the same concentration of a sulfhydral compound may slightly accelerate, inhibit or exert no effect whatsoever on the rate of cleavage. The variable in these experiments is the female whose eggs are used. That is to say, eggs from different females respond differently to these sulfhydral compounds. This great variability in the material has been previously pointed by Goldforb. It is indeed very striking in our experiments.

This variability which we did not expect does not permit us to come to any definite conclusions as yet as to the effect of sulfhydral compounds. However the indications are quite clear that they are not chemical stimuli for cell division in *Arbacia punctulata.*

—David E. Green.

THE OXIDATION-REDUCTION POTENTIAL IN STARFISH EGGS

A modified Thünberg technique was devised whereby the oxidation-reduction potential of starfish eggs could be measured with facility. We confirmed completely with one exception the micro-injection experiments of Chambers, Pollack and Cohen. The aerobic rH for pH 7 lies between 12 and 14, while the anaerobic rH lies below 4.

The kinetics of reduction has been studied quantitatively and the relationship between the rH of the dye and the ease of reduction worked out.

A very interesting result of our study is the finding that narcotics do not interfere with the reducing mechanisms of the cell. It is generally assumed that they have an inhibitory action. Further, eggs which have been cytolized are profoundly affected by narcotics. This discrepancy in behavior between intact and cytolyzed eggs is being further investigated.

—David E. Green.

The Collecting Net

A weekly publication devoted to the scientific work at Woods Hole.

WOODS HOLE, MASS.

Ware Cattell .... Editor

Assistant Editors

Margaret S. Griffin   Mary Eleanor Brown

Annaleida S. Cattell

EDITORIAL NOTES

The briefer research reports which have been included in THE COLLECTING NET during the summer have been based on the papers presented in the scientific meetings at the Marine Biological Laboratory. Many of these articles contain the results of unpublished work and must be considered as preliminary reports. We consider ourselves fortunate in having the privilege of printing this original material. The longer contributions by Drs. Michaelis, Parker, Spemann, Hisaw, Clark and Stockard are based on the evening lectures which they presented during the summer.

The cost of publishing THE COLLECTING NET is about $3,000.00 each summer. This figure is probably not much greater than the expense that would be entailed by the Marine Biological Laboratory if it undertook the separate publication of the lectures and seminar reports in book form. If the material were incorporated in the *Biological Bulletin*, the cost probably would be much less.

The income from advertising meets somewhat more than two-thirds of the cost of publication of our magazine. The scientific workers in Woods Hole should be under obligation to the manufacturers of, and dealers in, scientific apparatus and books whose advertising in THE COLLECTING NET made possible the prompt publication of the results of the research work carried out in their local laboratories.

Five one-hundred dollar scholarships have been made available through THE COLLECTING NET for students to return next summer as beginning investigators. The research grants will be assigned by a committee composed of the following men:

Professor E. C. McClung
Professor Alfred C. Redfield
Professor I. F. Lewis.

During the summer we have heard people remark:

(1) That the fence on the Bay Shore beach should be removed.

(2) That the Police Department should not permit parking on both sides of Main Street in Woods Hole.

(3) That equipment for the electrical amplification of the voice of speakers be installed in the auditorium of the Marine Biological Laboratory.

(4) That the variety and quality of the food served at the Mess Hall should be improved.

(5) That the M. B. L. Club needs a coat of paint.

To the Editor: *

Some time ago, we understand, there was trouble over the matter of late comers at meals, and the serving time was accordingly lengthened by fifteen minutes. Instead of helping the situation, it seems merely to have aggravated it. Certain people still persist in arriving at the tail end of the hour, expecting the best of service, and taking all the time they wish with their food. This letter is not a protest against the occasional late guest; it is not a protest against the scientist who frequently has to stand by his apparatus for a certain length of time, meal-time or not meal-time. It is a protest, however, on the part of the waiters of the Mess, against those who, apparently for no reason, make this a part of their daily routine. It would seem, in due fairness to all concerned, that these people should remember that we are not waiters by vocation, but biologists of a more or less embryonic nature. The majority of us came here for work—but in the laboratory, not the Mess. We feel that in most cases this habitual tardiness is due merely to thoughtlessness or to the fact that these people do not realize that to have late people at our tables means a considerable delay for us.

Moreover, the salary is far from enticing as it is: seven dollars a week (which just clears our board for us), remuneration for some thirty-one hours' work (four and a half hours per day under the best conditions), means a wage of about 22.6 cents per hour.

Often it is more than necessary that some of us work part of our way here; and this position is practically the only opportunity available at the M. B. L. for obtaining any financial aid. In fact, the question of whether or not we appear at Woods Hole often hangs on the matter of landing this position. With these facts in mind, it would seem that some could be more considerate.

This communication has been written in no spirit of petty criticism, nor has it been prompted by any individual's actions in particular. It has been written with the hope that in thus stating our case for all to see, a better understanding between the patrons of the Mess and the waiters might be attained and that, in so doing, a rather needlessly unpleasant situation could be bettered.

PAUL A. WALKER,
E. G. STANLEY BAKER,
JOHN T. CROLY,
HERBERT L. EASTLUCK,
PAUL A. NICOLL.

* Limited space has made it necessary to omit part of this communication.

ITEMS OF INTEREST

Professor H. S. Jennings and his family sailed for Japan in July, stopping in Hawaii en route. He has arrived in Tokyo, where he will be a lecturer at the Medical School of Keio University, Yotsuya, Tokyo. His son, Burridge, will take courses at the university there, and will return later to Johns Hopkins University. Professor and Mrs. Jennings expect to visit Europe before returning to the United States in September, 1932.

Miss Edwina Morgulis, is taking the leading part in a play entitled "Game," which is being staged for the benefit of the Sandwich hospital.

Dr. Thomas P. Hughes, who is now holding a position at the Rockefeller Institute, has been appointed to the International Health Board of the Rockefeller Foundation.

The U. S. Bureau of Fisheries station at Woods Hole recently had as their guests Dr. R. W. Dodgson of the Ministry of Agriculture and Fisheries at Conway, North Wales; Dr. C. M. Yonge from the Marine Biological Association Laboratory, Plymouth, England; and Dr. John Eyre from Guy's Hospital and the Fishmongers Company, London. They came down with Dr. H. D. Pease and Mr. A. S. Phillips of the Pease Laboratories in New York City. These men, together with Dr. Paul S. Galtsoff, had come down from Sayville, Long Island, where they attended the joint convention of the National Shellfisheries Association and the Oyster Growers and Dealers Association of North America, Inc.

Professor Charles Lawrence Bristol, professor emeritus of biology at New York University, died recently at his home on Long Island.

Dr. Kenneth B. Coldwater has been appointed instructor in biology at St. Louis University. He has held the same position at the University of Missouri since 1928.

The officers of the M. B. L. Club wish to call attention to the fact that their series of victrola concerts have been made possible through the generosity of a few persons who have permitted the use of their records for this purpose. They take this opportunity of expressing sincere appreciation to Dr. Grundfest, whose records of Bach, Beethoven, Brahms, Mozart, and Sibelius have furnished the music for many of the concerts, and whose suggestions and criticisms have facilitated the planning of programs. They are indebted to Mr. McGoun, for the Gilbert and Sullivan operas, to Dr. deRenyi for many of the shorter recordings, also to Miss Wilson, Dr. Wolf and Dr. Borodin.

THE OFFICIAL MEETING OF THE MARINE BIOLOGICAL LABORATORY

At the annual meeting of the Trustees of the Marine Biological Laboratory, Drs. E. G. Conklin and Charles Packard were elected to serve on the Executive Committee until 1933. They replace Drs. G. N. Calkins and L. L. Woodruff whose terms of office expired this year.

Two amendments were made to Article I of the By-Laws of the Corporation. The first sentence was altered to read:

I. The annual meeting of the members shall be held on the second Tuesday in August, at the Laboratory, in Woods Hole, Mass., at 11:30 A. M. daylight saving time, in each year and at such meeting shall choose by ballot a Treasurer and a clerk, who shall be, ex officio, members of the Board of Trutees as hereinafter provided.

The second sentence was altered to read:

"Trustees ex officio and emeritus shall have all rights of trustees except that trustees emeritus shall not have the right to vote"

The trustees elected the following individuals to membership in the Corporation:

Philip Bard, Assistant Professor of Physiology, Harvard Medical School.
H. B. Bigelow, Director, Oceanographic Institution, Woods Hole.
R. K. Cannan, Professor of Chemistry, University and Bellevue Hospital Medical College.
R. W. Gerard, Associate Professor of Physiology, University of Chicago.
Laurence Irving, Associate Professor of Physiology, University of Toronto.
E. O. Jordan, Professor of Bacteriology, University of Chicago.
B. P. Kaufmann, Professor of Biology, University of Alabama.
O. W. Richards, Instructor in Biology, Yale University.
Dorothy R. Stewart, Assistant Professor of Biology, Skidmore College.
Albert Tyler, Instructor in Embryology, California Institute of Technology.
Emil Witschi, Professor of Zoology, University of Iowa.

At the annual meeting of the Corporation the following members of the Corporation were elected to serve as trustees until 1935:

Drs. H. C. Bumpus, G. N. Calkins, W. C. Curits, B. M. Duggar, L. V. Heilbrunn, W. J. V. Osterhout, W. M. Wheeler and L. L. Woodruff.

Dr. H. B. Goodrich was elected trustee to serve until 1933, replacing Dr. E. P. Lyon who presented his resignation. Dr. Charles Packard was elected Clerk of the Corporation and Mr. Lawrason Riggs, Jr., was reelected Treasurer.

Captain Columbus Iselin of the *Atlantis* has gone to his home in New York City for a few days. He will return to Woods Hole next week.

ITEMS OF INTEREST

A PLAY ON PENZANCE POINT

"The Queen's Husband", a comedy by Robert Emmet Sherwood, will be presented by the Penzance Players on Friday evening, September 11, at "Gladheim", the residence of Dr. and Mrs. J. P. Warbasse on Penzance Point. The performance will begin promptly at 8:15.

The play enjoyed a very successful run on Broadway several years ago and since has become exceedingly popular with amateurs. The scene is laid in a mythical kingdom situated on an island in the North Sea. The play is built up around the efforts of the imperious Queen, who is obviously modelled after Queen Marie of Roumania, to manage her husband and the Kingdom as well as to arrange a "perfectly marvelous match" for her daughter.

The cast includes Margaret Kidder, Vera Warbasse, Alfred Compton, Frederick and Preston Copeland, Thomas Ratcliffe, Arthur and Wister Meigs, Comstock Glaser, George Clowes, William Woglum, and John Frost. Miss S. Goldie Balfour is directing the production.

No admission will be charged but a collection will be taken up to cover necessary expenses and the surplus proceeds given to the Collecting Net Scholarship Fund. It is hoped that everyone who can will come and enjoy it as much as the players have, at the same time helping a deserving cause to which Woods Holers have not had an opportunity to contribute before this season.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the hole turns to run from Buzzards Bay to Vineyard Sound:

Date	A. M.	P. M.
Aug. 29	5:41	5:56
Aug. 30	6:20	6:37
Aug. 31	6:55	7:14
Sept. 1	7:36	7:59
Sept. 2	8:13	8:40
Sept. 3	9:00	9:32
Sept. 4	9:43	10:24
Sept. 5	10:41	11:25
Sept. 6	11:34	——
Sept. 7	12:21	12:35
Sept. 8	1:25	1:40

In each case the current changes approximately six hours later and runs from the Sound to the Bay. It must be remembered that the schedule printed above is dependent upon the wind. Prolonged winds sometimes cause the turning of the current to occur a half an hour earlier or later than the time given above.

WOODS HOLE AT THE FLOWER SHOW

It is worthy of note that several of the Woods Hole amateur gardeners carried off honors at the annual Flower Show in Falmouth in August. In addition to a number of awards to Mrs. C. R. Crane for flowers and vegetables, Dr. Manton Copeland, Miss Tinkham, and Mrs. Clowes received special prizes for exceptional exhibits. Miss Tinkham won the state Blue Ribbon by a charming group to show phlox. A bee-hive was set among a riot of phlox in a corner of fence made of ingeniously stained and aged rails and posts, forming a picture characteristic of the exhibitor's mastery of the garden. Mrs. Clowes also won several first prizes for her taste and rare deftness and skill in beautiful special arrangements of flowers.

The exhibit of a miniature rock garden showing the variations in Cedums revealed one zoologist as indeed worthy of his title, Professor of Biology, a chair rapidly becoming a rarity. Be it noted, however, that some of our greatest zoologists have been constantly devoted to the study of plants. Dr. Manton Copeland was voted a special Bronze Medal, "State Award", even though he was not down as a competitor for prizes and exhibited merely because of interest in helping out. This award witnessed the generous appreciation of the professionals of the Flower Show for the lessons so adroitly, if unconsciously, taught by this amateur gardener but still scientific thinker. Here were suggestions of how to teach something of the scientific meaning and relations of the plants shown, while at the same time sacrificing nothing of practical value for what might be called academic.

Indeed the method of arrangement and labeling by inconspicuous, tasteful markers was exceptionally effective.

Dr. Copeland selected the single genus Cedum and gave a surprising lesson in botany and art by arranging its varieties among the rocks in adaptive groups and instructive contrasts. Here was presented an astonishing range of variation in one genus, a scientific study which should be seen widely abroad. In showing it the exhibitor demonstrated a practical experience in gardening and in artistic expression built on his scientific studies, every whit as convincing as the very creditable miscellaneous exhibits of his professional colleagues. They might well learn from him something of the value of scientific method. Such is the reaction of an appreciative amateur visitor. —*H. McE. K.*